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Virtual therapeutic exercise system for the treatment of metabolic syndrome

Sistema de ejercicios terapéuticos para el tratamiento del síndrome metabólico desde la virtualidad

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Abstract

Introduction: Metabolic syndrome is characterised by the appearance of obesity, diabetes mellitus and arterial hypertension. In Cuba, people are limited in their practice of therapeutic exercises to control this disease due to the lack of access to gyms. Therefore, this research provided a didactic means and an alternative for performing therapeutic exercises virtually. Research objective: To evaluate the effectiveness of the implementation of a virtual therapeutic exercise system for the control of abdominal obesity in the metabolic syndrome. Methods: A pre-experimental, analytical, minimal control study was conducted, incorporating a pre-test and post-test for a single control group, which was established within a Facebook group. Results: The system of therapeutic exercises carried out on the Facebook platform successfully reduced the levels of abdominal obesity, with the vast majority of participants reducing their weight, despite remaining in the same grade II obesity range and conducting the therapeutic exercises in a virtual environment. Conclusion: The analysis of the theoretical-methodological foundations supports the effectiveness of the virtual therapeutic exercise system in controlling abdominal obesity in metabolic syndrome, and justifies the particularities of the process through virtuality on how to programme, dose, control, and evaluate systematic practitioners with metabolic syndrome.

Keywords: Obesity, Virtuality, dose and practitioners.

Resumen

Introducción: el síndrome metabólico se caracteriza por la aparición de la obesidad, diabetes mellitus e hipertensión arterial. En Cuba las personas se limitan en la práctica de los ejercicios terapéuticos para el control de esta enfermedad dejando de asistir a los gimnasios, por lo que esta investigación aportó un medio didáctico y una alternativa para realizar ejercicios terapéuticos a través de la virtualidad. Objetivo de investigación: Evaluar la efectividad de la implementación de un sistema de ejercicios terapéuticos virtuales para el control de la obesidad abdominal en el síndrome metabólico. Métodos: se realizó un estudio analítico pre-experimental de control mínimo con pre-test y post-test para un solo grupo de control, incorporados a un grupo de Facebook. Resultados: el sistema de ejercicios terapéuticos realizado en la plataforma de Facebook consiguió reducir los niveles de obesidad abdominal, disminuyendo la gran mayoría de ellas el peso, a pesar de permanecer en el mismo rango de obesidad grado II y realizar los ejercicios terapéuticos desde un entorno virtual. Conclusión: el análisis de los fundamentos teóricos-metodológicos sustentan la efectividad del sistema de ejercicios terapéuticos virtuales para el control de la obesidad abdominal en el síndrome metabólico y justifican las particularidades del proceso a través de la virtualidad del como programar, dosificar, controlar y evaluar a los practicantes sistemáticos con síndrome metabólico.

Palabras claves: Obesidad, virtualidad, dosificar y practicantes.

Introduction

The metabolic syndrome is composed of a set of metabolic diseases that appear simultaneously, constituting risk factors in the same individual. It is characterised by the appearance of obesity, diabetes mellitus and arterial hypertension, which is why patients

with this pathology must continue their treatment (Carrera *et al.*, 2020).

In this sense, the Master's thesis of Carrera (2023), entitled "Physical exercise programme for the treatment of metabolic syndrome from a virtual environment" was used as a reference. This study was conducted during the COVID-19 pandemic,

during which participants successfully utilised virtuality as an alternative. For women with metabolic syndrome, with a predominance of obesity accompanied by hypertension and diabetes mellitus, this research provided a didactic means to perform therapeutic exercises using virtual learning environments to continue their therapeutic exercise treatment. (González *et al.*, 2022)

The first description of a patient with metabolic syndrome and hypertriglyceridaemia was made by Nicolaes Tulp (1593-1674), a Dutch surgeon and anatomist who went down in history for having posed for Rembrandt in his masterly canvas "Anatomy Lesson of Dr. Tulp", displayed in the Mauritshuis Museum in The Hague. However, in 1641, Tulp described the milky (lipemic) blood of a patient and established the relationship between this phenomenon and the consumption of fats, obesity, and the tendency to 'sanguinisation' (perhaps high blood pressure) (Marqués and Ordoñez, 2023).

Approximately 250 years ago, Giovanni Battista Morgagni (1682-1771), in the twilight of his life, wrote 'De sedibus et causis morborum per anatomen indagatis', a work that laid the foundations of modern pathological anatomy as a basis for pathology and clinical practice. In it, he described for the first time the increase in omental and mediastinal fat associated with abdominal obesity. He warned of the association between visceral obesity, hypertension, gout and arteriosclerosis. Morgagni's discoveries did not transcend the physicians of his time, and the importance of intra-abdominal fat accumulation was not considered again until later years (Belloni, 1974).

Vague (1911-2003), from the University of Marseille, described two distinct patterns of obesity, characterised by the distribution of body fat: android and gynoid. However, the definitive demonstration of the importance of abdominal obesity came with the Swedish epidemiological studies that introduced the waist-to-hip ratio as a more straightforward method of measuring abdominal obesity than the system devised by Vague. These studies confirmed that the waist-to-hip ratio was an independent predictor of cardiovascular mortality (Márquez and Ordoñez, 2023), and all these criteria for the diagnosis of metabolic syndrome remain valid today.

After explaining these problems, it is possible to emphasise the importance of identifying metabolic syndrome indicators promptly and understanding their relationship with therapeutic exercises (Romero, 2023).

It is essential to recognise that a lack of physical activity is a significant contributor to the development of diseases in humans. According to the International Federation of Sports Medicine (FIMS), a sedentary lifestyle is a significant risk factor for the development of chronic non-communicable diseases (diabetes mellitus type II, hypertension, fat metabolism disorders, degenerative joint diseases and osteoporosis), which are the leading causes of disease and mortality worldwide. It should be noted that therapeutic exercise is the systematic execution with a planning of postures, movements and physical activities with a defined purpose which is usually that the patient can have the means to enhance and improve physical functioning, psychological, mood, body aesthetics, reduce or prevent risk factors for health and optimise the general state of health in which it is located (Ripoll, 2020).

The research addressed practitioners who are obese and have limited time to perform therapeutic exercises in gyms or rehabilitation centres. Hence, the proposal is to use the platform to perform exercises at home. This research was conducted in a post-pandemic environment, from September 2023 to February 2024.

The virtual environment has had and continues to have an impact on modern lifestyle changes, contributing significantly to making women with obesity feel more comfortable. It enables them to engage in physical exercise in a relaxed and safe context that is more suitable for their needs. It is difficult to structure and organise groups of obese people in the community, and sometimes they feel ashamed or embarrassed about their physical appearance, which is why this virtual environment makes it easier for them to carry out their physical activities comfortably and without prejudice (Carrera, 2023).

Another aspect is that people often lack the time to perform exercises in a gym or rehabilitation centre, so they do them at home. This has led to the development of new methods for conducting therapeutic exercises through virtual platforms. From the

exploration carried out, it was detected that the majority of the systematic practitioners had participated in the aforementioned research, which they enjoyed because they did not have the time to attend the rehabilitation centre, hence the need to maintain their body weight through the virtual practice of therapeutic exercises and avoiding the increase in risk factors for this group of women with metabolic syndrome in our country. Thus, it is necessary to utilise virtual environments to maintain continuity in the therapeutic exercises, in this case, on the Facebook platform. In line with the above, the scientific question is stated as follows: Is the implementation of this virtual therapeutic exercise system effective in treating metabolic syndrome in women? To address this problem, the research objective is to evaluate the effectiveness of implementing a virtual therapeutic exercise system for controlling abdominal obesity in individuals with metabolic syndrome.

Methods

The research was conducted from September 2023 to February 2024. The sample selection consisted of women with metabolic syndrome who gave their consent to participate in the research and were also users of the Facebook platform. This was an analytical pre-experimental study with minimal control, incorporating a pre-test and post-test for a single control group, which was established within a Facebook group created to facilitate and monitor the therapeutic exercises proposed for the research.

The study population consisted of 100 women with metabolic syndrome who, before the pandemic, attended the Antonio Guiteras sports centre, located in the Habana del Este municipality, Province of Havana, Cuba.

Correspondingly, a Facebook group was created with the selected sample, which consisted of 80 women in total. The entire sample was made up of women with metabolic syndrome, aged between 45 and 55 years, who had abdominal obesity, diabetes mellitus and arterial hypertension, android phones, digital weights, measuring tapes and were Facebook users. The exclusion criteria consisted of women being over 55 years old. This platform was used to send the study instruments, including surveys, data for the instruments (body

weight and height), videos explaining what MS is and the importance of practising therapeutic exercises, educational talks, and infographics on metabolic syndrome.

The advantages and disadvantages of using a virtual environment were analysed to make the therapeutic exercise system viable for people with metabolic syndrome who, due to their work duties, find it difficult to attend a specialised centre for this purpose or a gym in their community.

The methods and means that could be adapted from the virtual environment for use in a therapeutic exercise system were analysed.

Furthermore, the system, with adaptations made from the virtual environment, was presented to a group of experts so that they could evaluate the proposal. The recommendations were evaluated in order to reorganise and complete the system of therapeutic exercises.

The anthropometric indices used were body mass index and waist-hip ratio. At the same time, height and body weight in kilograms were measured using digital scales in their homes and evaluated once a week to assess the differences between each of the research weeks.

Similarly, body weight in kg and height in cm were measured to determine BMI before and at the end of the therapeutic exercises.

Arterial hypertension was monitored using a digital sphygmomanometer, and measurements were taken before the start and at the end of the therapeutic exercises.

In the same way, heart rate measurements were taken before, during and at the end of the therapeutic exercises throughout the entire period of the study. The training pulse of each participant served as a starting point to maintain control over the dosage at each stage of the research.

Subsequently, the practice of therapeutic exercises began through the virtual Facebook platform, guided by a virtual instructor. In the same way, measurements of body weight in kg and height in cm squared were taken to determine the BMI before the exercises and at the end. Simultaneously, the heart rate was monitored through the platform group throughout the entire study period, using the training pulse of each participant as a starting point to maintain control of the dosage at each stage of the research. The exercises were

performed from Monday to Friday, with a duration of 1 hour, at a medium intensity, and a maximum frequency of 50-80%.

Among the therapeutic exercises chosen to be performed on the platform are low-impact aerobic exercises, which are the most recommended, as they produce an increase or maintenance of cardiorespiratory function or functional capacity, expressed by maximum oxygen consumption, an element considered a predictor of survival; they are generally of a continuous type and use large muscle groups (Jorquera and Cancino, 2012). Among the benefits that this type of activity has on cardiovascular system pathologies is the reduction of risk factors associated with metabolic syndrome. Hence, general strength exercises were performed, which allowed for the strengthening of the organism. Regarding physical capacity, flexibility was utilised to increase the ranges of joint amplitude and muscle and ligament elongation (Chávez and Zamarreño, 2016).

At the end of the research period, the final measurements of body weight and waist circumference were taken after the therapeutic exercise system had been implemented for 6 months.

The questions and surveys were administered to the study sample through a group created on the Facebook platform. To obtain the data for this research, an online survey technique (see Appendix 1: Survey) was used, which consisted of questions developed by a group of experts for the variable of metabolic syndrome and therapeutic exercises from the virtual environment, using a pilot test, where the therapeutic exercises with the adaptations made from the virtual environment were presented to a group of experts in the area of physical culture so that they could evaluate the proposal. The recommendations were evaluated to reorganise and complete the therapeutic exercises as part of the first round, and the suggestions made by the experts to the therapeutic exercises were taken on board.

Subsequently, in the second round, the experts reevaluated the proposal, which yielded positive results in each of the assessed aspects. This allowed for the practical testing of the proposed therapeutic exercises in a small sample, in the form of piloting, to verify whether the assessment

made by the experts was achievable in practice. Additionally, the documentary compilation technique was employed, allowing for the collection of relevant information with a high degree of veracity.

Therefore, for the validation of the therapeutic exercise system applied to the participant sample with metabolic syndrome, SPSS software for Windows, version 20, was used. In addition, the descriptive statistical techniques applied were the mean, standard deviation, coefficient of variation, standard error of the mean and the T-test for related samples.

Table 1. Therapeutic Exercise System.

Modality	Exercises
	Dosage
	Time %20-30 minutes
	Average Intensity
Body vive (aerobic)	March
	Touching Steps
	Crossing Steps
	Knee Lift Steps
	Forward Touch Steps
	Lateral Touch Steps
	Toe Forward Touch Steps
	Touch steps with toe support to the front left
	Touch steps with toe support backwards
	Leg lift steps backwards.
Modality	Exercises
Yoga (Flexibility)	UrdhvaMukhaSvanasana or Upward Facing Dog Pose
	Eka Pada Supta Pawanmuktasana or Knee to Chest Lying Down Posture
	Supta Padangustasana or Lying Down Big Toe Posture
	Urdhva Prasarita Padasana or Legs Raised Upward Posture
Modality	Exercises
Body Pump (Strength)	Triceps Push-up
	Crunch
	Alternating single-leg Extensions

Source: Authors.

Results

Immediately after the therapeutic exercise system was implemented in the virtual Facebook environment, users decreased their levels of abdominal obesity, with the vast majority reducing their weight, despite remaining in the same grade II obesity range, according to the body mass index (Tarriba et al., 2023). The above can be confirmed through the descriptive statistical technique used in this research, indicating that the therapeutic exercise system was revealing, as it determined changes in the results of the practitioners, specifically in terms of waist-hip index (WHI), body mass index, and body weight in kilograms.

After structuring and implementing the therapeutic exercise system for the virtual Facebook environment, the practitioners showed interest and practiced them systematically, managing to reduce their levels of abdominal obesity, reducing the vast majority of them their weight, despite remaining in the same range of obesity grade II, according to the body mass index (Tarriba *et al.*, 2023). The above can be confirmed through the descriptive statistical technique used in this research, which indicates that the therapeutic exercise system was revealing, as it determined changes in the results of the practitioners, specifically in terms of waist-hip index (WHI), body mass index, and body weight in kilograms.

The height and weight in kilograms were used to estimate the degree of obesity in the women of the sample under study. The initial and final BMI evaluations showed that the average behaviour was in a lower range, despite remaining within the degree of obesity II, after having carried out the therapeutic exercise system, which demonstrated homogeneity, indicating a decrease in the values of the systematic practitioners.

In terms of the Waist-Hip Index (WHI), the initial and final mean values were very significant <0.001 in the results obtained, which indicates that the therapeutic exercise system for the treatment of metabolic syndrome was effective, demonstrating that although the therapeutic exercises were carried out virtually, it is a judicious alternative that helped the practitioners to get out of their comfort zone, reduce cardiovascular risk factors and improve their quality of life.

Subsequently, a summary table is presented, displaying the statistical data for weight, BMI, standard error of the mean, and WHI, which includes the data for each variable. These results indicate that the smaller the standard error, the more representative the study sample is of the general population.

Table 2. Summary of the statistical data of weight, BMI and WHI.

Statistical	Weight		BMI		WHI	
	Initial	End	Initial	End	Initial	End
Mean	100,16	95,53	37,09	35,37	97,44	88,61
Standard deviation	2,48	1,63	1,51	1,22	15,58	2,30
Coe. V.	2,47	1,70	4,07	3,44	15,98	2,59
Standard error of the mean	0,27	0,18	0,16	0,13	1,74	0,25
Sig	$<0,001$		$<0,001$		$<0,001$	

Source: Authors.
References

WHI: waist-hip index
BMI: Body Mass Index
Sig: p value
Coe. V.: coefficient of variation

Discussion

In the research reviewed, most authors recommend the practice of therapeutic exercises as a treatment. According to Alonso (2008), there is no specific pharmacological treatment for this diagnosis. Its treatment consists of treating the underlying diseases and performing physical exercises (García, 2022). Above all, the prevention of cardiometabolic disease with dietary interventions and lifestyle changes may be more effective in preventing the development of metabolic syndrome than pharmacological treatment. (Alonso, 2008, cited in Julitbert, 2022).

In this sense, we agree with García (2022), as it attaches great importance to the practice of therapeutic exercise and recommends it as part of the treatment that a person with MS should receive, in addition to basic treatment. In Cuba, people with an active lifestyle see their possibilities of continuing with their therapeutic treatments reduced, due to the little time they have to practice therapeutic exercises to control the risk factors of MS (Carrera, 2023).

The study allowed for the assessment of the level of obesity in the population through BMI. Initially, it was found that the entire study sample presented with obesity, a finding consistent with those of Gonzales *et al.* (2021) and other researchers, who have observed that obesity affects the health of the population.

Therefore, it is necessary to highlight that an elevated Body Mass Index is a fundamental component in the diagnosis of MS as a risk factor, as stated by PAHO (2019) in its study. Hence, the importance of maintaining an adequate weight in middle age through physical activity is emphasised.

According to the WHO (2018, cited in PAHO, 2019), therapeutic exercise is an indispensable medicine for the most vulnerable patients with metabolic syndrome; this research demonstrates this with the results obtained in the study. It was necessary to transfer the therapeutic exercises to other environments, such as virtual ones. That is why the contribution of this research was the adaptation of the

therapeutic exercise system to enable its implementation in virtual environments (PAHO, 2019).

In this sense, the author used Facebook's virtual environment for the research, as it is interactive and has a great capacity to connect several users at the same time, as well as being linked to the Messenger application, which in 2016 introduced group video calls of up to 50 participants where only six people can use the camera at the same time and the rest communicate through voice messages. This application is the most suitable alternative for exercising a group of people with SM. The creation of this Facebook group made it possible to send information, such as surveys, videos, educational talks, infographics about SM and therapeutic exercises.

We agree with Juanes and Rodríguez (2021), who recognise that virtual physical education has become an effective tool that can contribute to the quality of life of people in isolation and for people who do not have time to attend rehabilitation centres or gyms. The pedagogy of therapeutic exercises has been oriented towards discovering new methods and strategies to reach more people in the most effective way. The study suggests that a virtual environment can serve as an alternative to traditional therapeutic exercise practice.

Díaz-Canel (2023) stated that hybrid education as a teaching-learning modality became particularly relevant during the confinement caused by the COVID-19 pandemic. At present, it remains as a viable option for teaching innovation by combining the face-to-face and virtual modality, in addition to broadening the spectrum of didactic and methodological alternatives in a context of digital transformation characterised by an extensive use of Information and Communication Technologies (ICT) in all areas of society, especially in the area of therapeutic exercise (Inganzo and Otero, 2024).

Conclusions

The analysis of the theoretical-methodological foundations that support the therapeutic exercises in the treatment of metabolic syndrome provided elements that justify that, through virtuality, it was possible to control a group of women with this

metabolic syndrome, which allowed them to reduce the risk of suffering from cardiovascular diseases.

Through the use of the virtual environment and the therapeutic exercises, it was possible to reduce body weight and thus control the body mass index, as well as the abdominal waist, which made it possible to control the waist-hip index, thus reducing the risk factors involved in metabolic syndrome, after having carried out the therapeutic exercises from the Facebook platform.

The evaluation of the results obtained from the virtual application of therapeutic exercises was positive, demonstrating their relevance through the criteria of specialists, as well as the effectiveness of the exercises and their subsequent practical verification, which was developed through virtual means.

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Appendix # 1

Survey of Physical Culture experts

Name and surname:

Occupation:

Years of experience:

School level:

You have been selected to evaluate a therapeutic exercise system for the treatment of metabolic syndrome from a virtual environment. Mark with an x the answer you consider in each question. If you mark "No", please justify your choice. Your answers are important for this research. Thank you for your collaboration.

1. Do you know any system for metabolic syndrome from a virtual environment?

a) Yes___ b) No___ c) I don't know___

2. Do you think that the proposed therapeutic exercises are suitable for the treatment of metabolic syndrome?

a) Yes___ b) No___ c) I don't know___

3. Out of the aerobic exercises presented, do you consider that they correspond to the system of therapeutic exercises?

a) Yes___ b) No___ c) I don't know___

4. Do you consider that the proposed yoga exercises can be worked on virtually?

a) Yes___ b) No___ c) I don't know___

5. Out of the proposed strength exercises, such as Body Pump, do you think that they

are in accordance with the system of therapeutic exercises presented?

a) Yes____ b) No____ c) I don't know____

6. Do you think that therapeutic exercises for patients with metabolic syndrome can be evaluated virtually?

a) Yes____ b) No____ c) I don't know____

7. Do you consider that the system of therapeutic exercises with the content of Body Pump and Body Vibe is suitable for people with metabolic syndrome?

a) Yes____ b) No____ c) I don't know____

8. Do you think that this therapeutic exercise system can be applied to a group of people with metabolic syndrome in a virtual environment?

a) Yes____ b) No____ c) I don't know____