



FACULTAD DE CIENCIAS DE LA SALUD
CARRERA PROFESIONAL DE MEDICINA HUMANA

**“Efectos del ejercicio aeróbico sobre los componentes del
síndrome metabólico en adultos mayores con diabetes mellitus
tipo 2: Revisión sistemática”**

Tesis para optar el título profesional de:

MÉDICO CIRUJANO

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ACTA DE SUSTENTACIÓN DE TESIS

Lima, 11 de febrero de 2022.

Los integrantes del Jurado de tesis:

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Se reúnen para evaluar la tesis titulada:

Efectos del ejercicio aeróbico sobre los componentes del síndrome metabólico en adultos mayores con diabetes mellitus tipo 2: Revisión sistemática

Presentada por los estudiantes:

Mercedes Miranda Tueros y Joshua Jimmy Rony Ramirez Peña

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Luego de haber evaluado el informe final de tesis y evaluado el desempeño de los estudiantes de pregrado de la carrera Medicina Humana en la sustentación, concluyen de manera unánime (x) por mayoría simple () calificar a:

Tesis: Mercedes Miranda Tueros			Nota (en letras): 16 (dieciséis)	
Aprobado ()	Aprobado - Muy buena (x)	Aprobado - Sobresaliente ()	Desaprobado ()	
Tesis: Joshua Jimmy Rony Ramirez Peña			Nota (en letras): 16 (dieciséis)	
Aprobado ()	Aprobado - Muy buena (x)	Aprobado - Sobresaliente ()	Desaprobado ()	

Los miembros del jurado firman en señal de conformidad.



Mg. Marlon Augusto Yovera Aldana
Presidente del Jurado



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Declaración de impacto:

Esta revisión sistemática aporta una visión completa y actual de los efectos del ejercicio aeróbico sobre los componentes del síndrome metabólico en la población diabética geriátrica, así como contribuye a que futuras investigaciones se centren en este grupo y tipo de ejercicio específico ya que, como se ha visto en nuestra revisión sistemática, es una estrategia beneficiosa. Certificamos que este trabajo es novedoso ya que no ha habido una revisión sistemática previa sobre esta población asociada al ejercicio aeróbico.

Puntos clave

- El ejercicio aeróbico se asoció con una mejora en los componentes del síndrome metabólico.
- El ejercicio aeróbico no mostró efectos adversos importantes en adultos mayores

¿Por qué importa este estudio?

- El ejercicio aeróbico puede ser una intervención prescrita para pacientes mayores con DT2

Resumen

Antecedentes: Se recomienda la actividad física para mejorar los parámetros metabólicos de los pacientes diabéticos, sin embargo, no existe consenso sobre cuáles podrían ser los efectos potenciales del ejercicio aeróbico sobre el perfil metabólico en los adultos mayores diabéticos, por lo que realizamos una revisión sistemática y metaanálisis.

Métodos: Utilizamos las bases de datos PubMed/Medline, Scopus, Cochrane library, Web of Science y el buscador, Google Scholar. Se seleccionaron los ensayos controlados aleatorizados (ECA) según los criterios de inclusión. Dos revisores determinaron de forma independiente si los estudios cumplían con los criterios de inclusión, extrajeron los datos y utilizaron la herramienta Cochrane de riesgo de sesgo (ROB). Los análisis cuantitativos se realizaron en R V. 4.0.5 utilizando efectos aleatorios.

Resultados: Las búsquedas identificaron 8697 estudios, de los cuales 7 ECA se incluyeron en la síntesis cualitativa. Se evaluó que la mayoría de los estudios tenían un ROB alto o bajo en al menos tres dominios. El metaanálisis mostró que el ejercicio aeróbico fue eficaz para mejorar los niveles de glucosa (diferencia de medias estandarizada [SMD]: -1,04; intervalo de confianza [IC] del 95 %: -1,27; -0,81), presión arterial sistólica ([SMD]: -0,79 ; [IC]: -1,02; -0,56), presión arterial diastólica ([SMD]: -0,75; [IC]: -0,98; -0,52), hemoglobina glucosilada ([SMD]: -0,57; [IC]: -0,77 ; -0,37), HDL ([SMD]: 0,35; [IC]: 0,15; 0,55), triglicéridos ([SMD]: -0,26; [IC]: -0,47; -0,06). No se informaron efectos adversos significativos.

Conclusiones: El ejercicio aeróbico demostró tener una mejoría significativa en los componentes del síndrome metabólico en adultos mayores diabéticos y no se reportaron efectos adversos importantes. Sin embargo, recomendamos más ECA que tengan un mayor tiempo de intervención para establecer el impacto sobre los síntomas y las complicaciones.

Palabras clave

Exercise, Diabetes Mellitus, Aged, Systematic Review, Metabolic Syndrome.

INTRODUCCIÓN

Se estima que para el año 2050, la población de adultos mayores será el doble que la del censo del año 2019, por lo que una de cada 6 personas en el mundo tendrá 65 años o más¹. Además, patologías como la diabetes mellitus tipo 2 (DT2) y el síndrome metabólico acompañan a esta población^{2,3}. Estas dos condiciones están estrechamente relacionadas y ambas aumentan el riesgo de complicaciones cardiovasculares fatales a corto plazo, como isquemias cardíacas o enfermedad cerebrovascular^{4,5}.

Actualmente, las guías disponibles recomiendan la actividad física junto con la dieta y la medicación para mejorar los parámetros glucémicos y lipídicos en pacientes con diabetes^{6,7}. Dentro del entrenamiento físico, existen varios tipos de ejercicios de utilidad demostrada, entre los que destacan el ejercicio aeróbico, de resistencia y el ejercicio de alta intensidad con bajo volumen^{8,9}. El ejercicio aeróbico ha sido el más estudiado y se define como cualquier trabajo que

desarrolle la aptitud cardiovascular y pulmonar, utilizando el oxígeno como sustrato metabólico ¹⁰. Esto incluye entrenamientos de diferentes intensidades, desde caminar a paso ligero hasta trotar, andar en bicicleta o nadar ^{10,11}. Se ha informado que este tipo de ejercicio conduce a diferentes beneficios, como una mejora en la sensibilidad a la insulina, aumento de la fibrinólisis, disminución de los triglicéridos y la presión arterial, todo lo cual mejora el pronóstico de un paciente con diabetes ¹²⁻¹⁵.

A pesar de estos amplios beneficios, el ejercicio físico no se puede prescribir sin restricciones. La población adulta mayor se caracteriza por tener en la mayoría de los casos limitación de movilidad, obesidad, discapacidad visual o enfermedad cardiovascular, sin mencionar que a la población geriátrica con diagnóstico de diabetes, se le suma un mayor riesgo de hipoglucemia y síndrome de fragilidad ¹⁶⁻¹⁹. Y, aunque las pautas de la guía “Physical Activity Guidelines for Americans”²⁰ recomiendan que los adultos mayores de 65 años realicen al menos 150 min de actividad física aeróbica de intensidad moderada o 75 min de actividad física aeróbica de intensidad vigorosa por semana, los efectos potenciales del ejercicio aeróbico sobre los agentes metabólicos marcadores para el control adecuado de la diabetes en personas mayores y la seguridad de su prescripción no se conocen completamente ²¹.

Se realizó una revisión sistemática con metaanálisis para evaluar los efectos del ejercicio aeróbico en adultos mayores diagnosticados con diabetes sobre los componentes del síndrome metabólico. Esto proporcionará a los médicos y especialistas una visión general de la evidencia científica sobre una posible opción de tratamiento, que ayudará en el manejo de esta población.

METODOS

Esta revisión sistemática se realizó de acuerdo con las directrices “Systematic Reviews and Meta-Analyses (PRISMA) 2020”. El protocolo fue registrado en PROSPERO con el número de CRD42021250115.

Criterios de inclusión

Se seleccionaron los ensayos clínicos aleatorizados (ECA) que incluyeron los siguientes a) pacientes con DT2, b) que evaluaron a adultos mayores (mayores de 60 años), c) con texto completo disponible y d) y cuya intervención fuera cualquier tipo de ejercicio aeróbico durante un tiempo mínimo de 12 semanas en comparación con el estándar de atención o ninguna intervención. La definición de ejercicio aeróbico se consideró de acuerdo con las pautas de guía “Physical Activity Guidelines for Americans” realizadas por el Departamento de Salud y Servicios Humanos de los Estados Unidos ²⁰. Se tuvo en cuenta la intensidad del ejercicio según lo recomendado ¹¹. Se excluyó cualquier otro tipo de publicación (cartas al editor, reporte de casos, estudios observacionales, revisiones narrativas y sistemáticas).

Estrategia de búsqueda

Se realizó una búsqueda sistemática en las siguientes bases de datos: Pubmed/Medline, Scopus, Web of Science, Cochrane Central y, finalmente, y el buscador Google Scholar para literatura gris; de 2011 al 5 de febrero de 2021. La estrategia de búsqueda incluyó términos de Medical Subject Headings (MeSH) y palabras relacionadas para "Diabetes mellitus" y "ejercicio" o "entrenamiento aeróbico". Se puede revisar en el anexo 1. No se hicieron restricciones con respecto al idioma o área geográfica.

Selección de estudios y extracción de datos

Los resultados de la búsqueda electrónica se importaron al programa de gestión de referencias EndNote X9; seguido de esto, se eliminaron los registros duplicados de acuerdo con los procedimientos descritos por Bramer et al²². Posteriormente, dos autores (MMT y JRP) examinaron de forma independiente los títulos y resúmenes de acuerdo con los criterios de inclusión y exclusión. Se seleccionaron los estudios relevantes y se realizaron búsquedas de textos completos para una evaluación adicional. Las discrepancias en las selecciones se resolvieron por consenso y, en última instancia, se consultó a un tercer autor (IPT). La lista completa de artículos excluidos en esta etapa del texto completo está disponible en el anexo 2.

Dos autores (JRP y MCL) extrajeron de forma independiente los datos de cada artículo incluido utilizando un formulario estandarizado en Microsoft Excel. Un tercer autor verificó la exactitud de los datos antes del análisis. Para los resultados dicotómicos, se extrajeron las frecuencias absolutas y relativas. Para los resultados continuos, se extrajeron las mediciones basales y de seguimiento, así como el cambio entre ellas.

Resultados

Los resultados primarios fueron los componentes del síndrome metabólico según la Federación Internacional de Diabetes (FID) ²³, glucosa en ayunas (mg/dl), presión arterial sistólica (PAS, mmHg), presión arterial diastólica (PAD, mmHg), lipoproteínas de alta densidad (HDL, mg/dl), triglicéridos (mg/dl) y circunferencia de la cintura (cm/pulgada). También se consideró la hemoglobina glicosilada (HbA1c, %) debido a la importancia clínica que representa. Para interpretar el

tamaño del efecto, se utilizaron las reglas de Cohen. ²⁴

Análisis por subgrupos

El análisis de subgrupos consistió en la intensidad del ejercicio, si hubo supervisión del ejercicio o no, y la duración total en horas (>30 horas y ≤ 30 horas). En caso de intensidad se dividió en Alta o vigorosa (≥ 6 METS, frecuencia cardíaca máxima ≥ 70%), Baja o moderada (<6 METS, Frecuencia cardíaca máxima <70%) ¹¹ y no reportada.

Evaluación del riesgo de sesgo

Los ensayos clínicos aleatorizados se evaluaron mediante la Herramienta Cochrane de Riesgo de Sesgo para Ensayos Aleatorios (RoB 2) ²⁵. Esta herramienta evalúa varios dominios de los que puede haber surgido el sesgo: proceso de asignación al azar, desviaciones de las intervenciones planificadas (efecto de la asignación de la intervención), datos de resultado faltantes, medición de resultados y selección de resultados informados. El riesgo de sesgo por dominio sigue un algoritmo basado en el juicio para concluir si existe bajo riesgo, algunas preocupaciones o el alto riesgo por dominio y ensayo. Un ECA con un alto riesgo de sesgo en cualquier ítem se consideró en alto riesgo de sesgo. La evaluación RoB 2.0 fue realizada de forma independiente por dos autores (MCL, MMT), y las discrepancias se resolvieron mediante discusión o consultando a un tercer autor (IPT).

Análisis estadístico

Todos los metaanálisis se realizaron utilizando el método de varianza inversa y el modelo de efectos aleatorios. La varianza entre los estudios (τ^2) se estimó mediante con la herramienta DerSimonian-Laird. El efecto agrupado de cada resultado se determinó mediante la diferencia de medias estandarizada (DME) de

los valores de cambio entre los grupos de intervención y control con los intervalos de confianza (IC) del 95%. Para los ECA que no informaron desviaciones estándar para la diferencia de medias, se realizó una imputación a partir de otros estudios disponibles, tal como recomienda el Manual Cochrane²⁶. La heterogeneidad entre los estudios se evaluó mediante la estadística I². La heterogeneidad se definió como baja si I² <30%, moderada si I² = 30-60%, y alta si I² > 60%. Todo lo anterior se presentó como un gráfico “Forest plot” para cada resultado.

Para investigar la fuente de heterogeneidad, el análisis de subgrupos se consideró por separado para cada subgrupo y se realizó de acuerdo con la intensidad del ejercicio, la supervisión del rendimiento del ejercicio y el tiempo total de intervención. La función de metacont del meta-paquete en R 4. Se utilizó 0,5 (www.r-project.org).

Certeza de la evidencia

Se utilizó el enfoque de Evaluación, Desarrollo y Desarrollo de la Calificación de las Recomendaciones (GRADE)²⁷ para evaluar la calidad de la evidencia para todos los resultados. Al utilizar la metodología GRADE, se consideraron los siguientes criterios para evaluar la calidad de los estudios: riesgo de sesgo, inconsistencia, imprecisión, sesgo de publicación, gran magnitud del efecto, gradiente dosis-respuesta, efecto de la confusión residual plausible y que tan indirecto sea. Generamos la tabla Resumen de Hallazgos (SOF) utilizando el software GRADE pro.

Consideraciones éticas

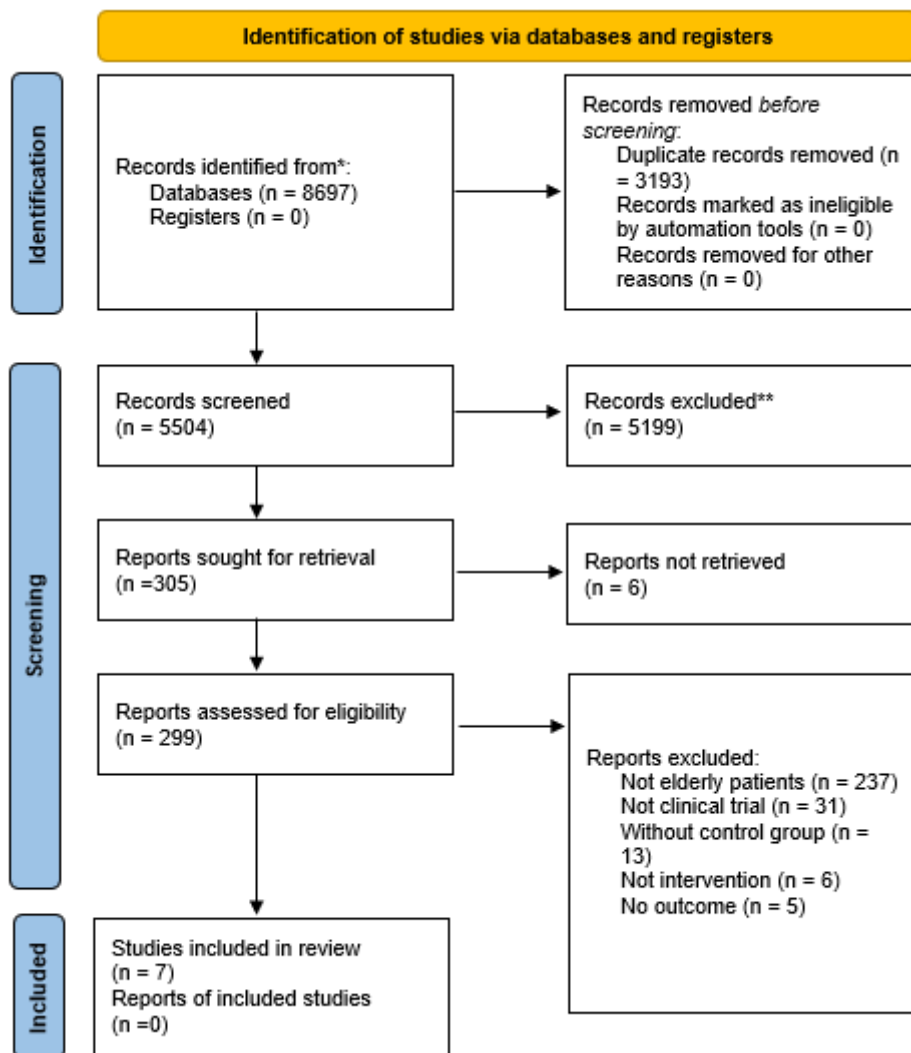
Se trata de una revisión sistemática de información publicada y abierta en la que no participaron sujetos humanos. La aprobación de un comité de ética no era

necesaria. No hubo manipulación de datos, y se evaluó a través de etapas para asegurar la fidelidad de los datos presentados en este estudio.

RESULTADOS

Se identificaron un total de 8697 resúmenes en las bases de datos y se eliminaron 3.193 duplicados. Después de evaluar por título y resumen, se dejaron 305 para la evaluación a texto completo. Finalmente, 7 artículos cumplieron con los criterios de inclusión, el proceso de selección completo se puede encontrar en la Figura 1.

Figura 1. Diagrama de selección de estudios PRISMA.



Características de los estudios incluidos

Las principales características de los 7 estudios se resumen en el anexo 3. Se evaluaron un total de 386 participantes. La edad media osciló entre 62,9 y 73,2 años. Dos estudios procedían de Canadá. Corea, España, Irán, China y Egipto tuvo un estudio. En cuanto al tipo de intervención, todos los estudios ²⁸⁻³⁴ utilizaron una caminadora o la actividad de caminar. La duración de la intervención varió de 12 a 24 semanas y entre los que informaron la intensidad del ejercicio, 50% fueron de alta intensidad. Entre los 7 ensayos incluidos, 1 ensayo ³⁰ demostró un alto riesgo de sesgo en general (anexo 4).

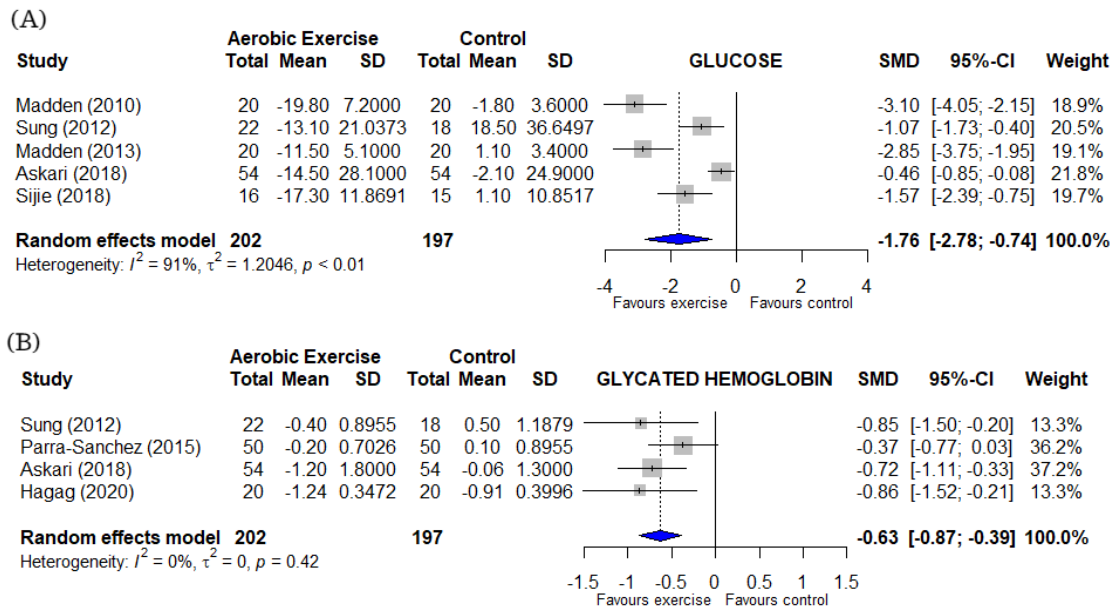
Resultados primarios

Entre los 7 ensayos, los metanálisis realizados para cada resultado son los siguientes:

Con respecto a la glucosa en ayunas, en 5 ECA ^{28-30,32,33,35,36}, incluidos 259 participantes, el ejercicio aeróbico redujo significativamente los valores de glucosa ([DME]: -1,76; IC del 95%: -2,78; -0,74; I2 = 91%) en comparación con el grupo control (Figura 2A).

En relación con la hemoglobina glicosilada, 4 ECA ^{30-32,34-37}, incluyeron a 288 participantes, el ejercicio aeróbico redujo significativamente los valores de HbA1c ([DME]: -0,63; IC del 95%: -0,87; -0,39; I2 = 0 %) en comparación con el grupo control (Figura 2B).

Figura 2. Diferencia de medias estandarizada entre el ejercicio aeróbico y los grupos de control, un metanálisis del modelo de efectos aleatorios. (A) Glucosa en sangre en ayunas; (B) Hemoglobina glicosilada.

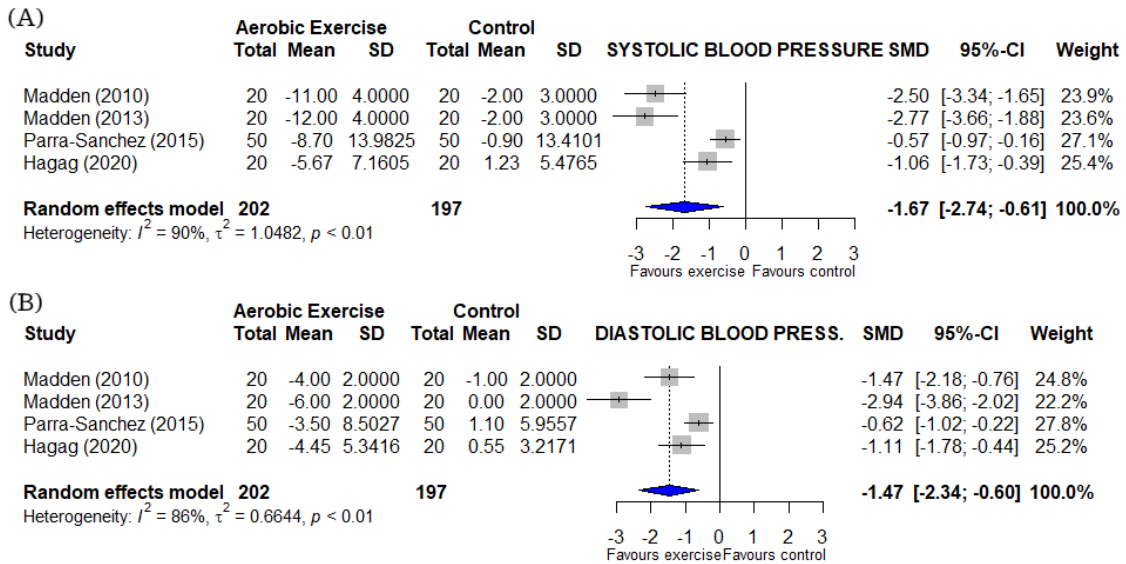


DE: desviación estándar, DME: diferencia de medias estandarizada, IC: intervalo de confianza

Con respecto a la presión arterial sistólica, en 4 ECA incluyendo 220 participantes, el ejercicio aeróbico redujo significativamente los valores de PAS ([DME]: -1,67; IC del 95%: -2,74; -0,61; $I^2 = 90\%$) en comparación con el grupo control (Figura 3A).

En cuanto a la presión arterial diastólica, en 4 ECA ^{28,29,31,34,35,38} que incluyeron 220 participantes, el ejercicio aeróbico redujo significativamente los valores de PAD ([DME]: -1,47; IC del 95%: -2,34; -0,60; $I^2 = 86\%$) en comparación con el grupo control (Figura 3B).

Figura 3. Diferencia de medias estandarizada entre el ejercicio aeróbico y los grupos de control, un metanálisis del modelo de efectos aleatorios. (A) Presión arterial sistólica; (B) Presión arterial diastólica

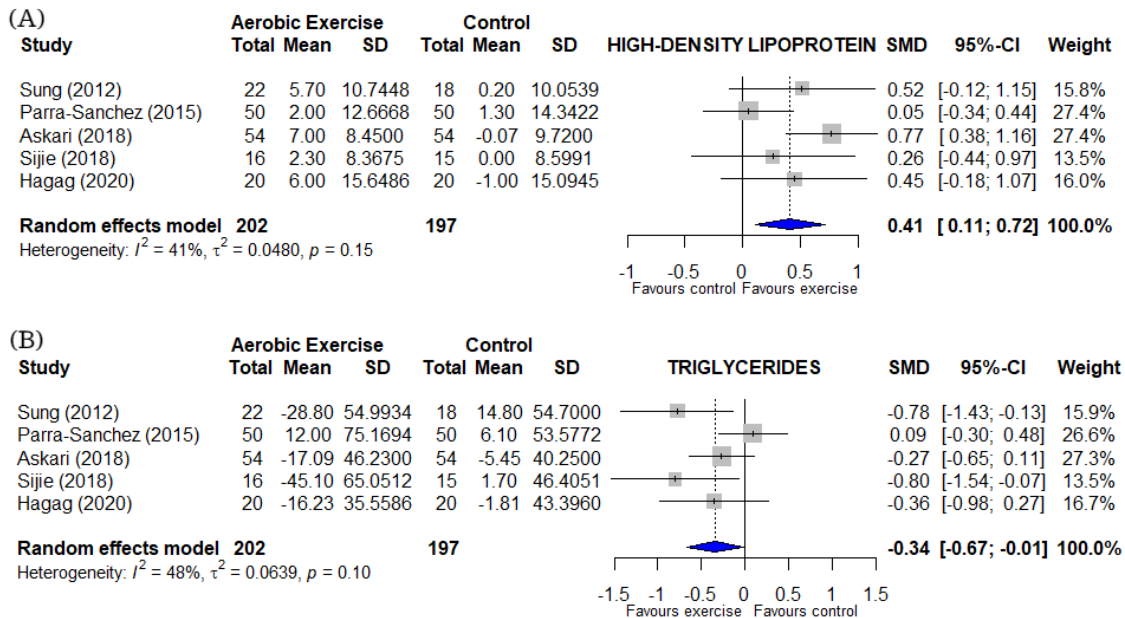


DE: desviación estándar, DME: diferencia de medias estandarizada, IC: intervalo de confianza

Con respecto a los niveles de HDL, en 5 ECA , incluidos 319 participantes, el ejercicio aeróbico aumentó significativamente sus valores ([DME]: 0,41; IC del 95%: 0,11; 0,72; I2 = 41%) en comparación con el grupo control (Figura 4A).

Con respecto a los niveles de triglicéridos, en 5 ECA ³⁰⁻³⁵incluyendo 319 participantes, el ejercicio aeróbico redujo significativamente los valores de triglicéridos ([DME]: -0,34; IC del 95%: -0,67; -0,01 ; I2 = 48%) en comparación con el grupo control (Figura 4B).

Figura 4. Diferencia de medias estandarizada entre el ejercicio aeróbico y los grupos de control, un metanálisis del modelo de efectos aleatorios. (A) Lipoproteína de alta densidad; (B). Triglicéridos



DE: desviación estándar, DME: diferencia de medias estandarizada, IC: intervalo de confianza

No se realizó un metanálisis de la circunferencia de la cintura ya que solo se encontró 1 ECA³³, sin embargo, hubo una reducción significativa entre el grupo de ejercicio aeróbico y el grupo de control ($p < 0,001$).

Con respecto al análisis de sensibilidad, ningún estudio individual afectó significativamente el resultado agregado en ningún resultado. (anexo 5).

Efectos adversos

Dos de los siete ensayos reportaron algunos efectos adversos (anexo 3). Madden et al²⁹ reportaron un caso de síncope a masaje carotídeo, esto ocurrió tanto antes de la realización del ejercicio como una vez que se completó. Parra-Sanchez et al

³¹ reportaron un caso de esguince en el grupo de intervención, y dos accidentes cerebrovasculares, uno en el grupo de intervención y el otro en el grupo de control.

Análisis por subgrupos

Se realizó un análisis de subgrupos para evaluar los resultados en base a algunas variables como la intensidad del ejercicio, la supervisión del rendimiento del ejercicio y el tiempo total de la intervención (Anexo 6).

Con respecto a los niveles de glucosa en ayunas, la presión arterial sistólica y diastólica, todos los subgrupos fueron estadísticamente significativos, excepto los ensayos que no informaron la intensidad del ejercicio.

Con respecto a la disminución de los triglicéridos, los ensayos que no informaron la intensidad del ejercicio, aquellos con una duración total de la intervención menor o igual a 30 horas, y aquellos con o sin la supervisión del cumplimiento del ejercicio no tuvieron diferencias estadísticamente significativas entre la intervención y el grupo control.

Acerca de la elevación del HDL, sólo los ensayos que no supervisaron el rendimiento del ejercicio tienen una diferencia estadísticamente significativa entre el grupo de intervención y el grupo de control. En cuanto a la disminución de la HbA1c, todos los subgrupos fueron estadísticamente significativos.

GRADE Resumen de los hallazgos

El enfoque GRADE mostró evidencia de certeza muy baja en la mayoría de los resultados primarios, excepto la presión arterial diastólica y sistólica, que tuvo una certeza moderada de la evidencia, y la glucosa en ayunas que tuvo una certeza alta

de la evidencia. (Tabla 1).

Tabla 1. Summary of findings. Aerobic exercise compared to control for components of metabolic syndrome in the elderly

Patient or population: components of metabolic syndrome in the elderly

Setting:

Intervention: aerobic exercise

Comparison: control

Outcomes	No of participants (studies) Follow-up	Certainty of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with control	Risk difference with aerobic exercise
fasting glucose (FG)	259 (5 RCTs)	⊕⊕⊕⊕ High ^{a,b,c}	-	-	SMD 1.76 SD lower (2.78 lower to 0.74 lower)
systolic blood pressure (SBP) follow-up: mean 3 months	220 (4 RCTs)	⊕⊕⊕○ Moderate ^{a,c,d}	-	-	SMD 1.67 SD lower (2.74 lower to 0.61 lower)
diastolic blood pressure (DBP) follow-up: mean 3 months	220 (4 RCTs)	⊕⊕⊕○ Moderate ^{a,c,e}	-	-	SMD 1.47 SD lower (2.34 lower to 0.6 lower)
high-density lipoproteins (HDL) follow-up: mean 3 months	319 (5 RCTs)	⊕○○○ Very low ^{a,c,f}	-	-	SMD 0.41 SD higher (0.11 higher to 0.72 higher)
triglycerides (TG) follow-up: mean 3 months	319 (5 RCTs)	⊕○○○ Very low ^{a,c,f}	-	-	SMD 0.34 SD lower (0.67 lower to 0.01 lower)

Glycosylated hemoglobin (GH) follow-up: mean 3 months	288 (4 RCTs)	⊕○○○ Very low ^{a,c,f}	-	-	SMD 0.63 SD lower (0.87 lower to 0.39 lower)
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***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **SMD:** standardized mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

- a. Most studies has "some concerns" in domain one
- b. The value of I2 is 91% on this outcome
- c. Different type and duration of interventions
- d. The value of I2 is 90% on this outcome
- e. The value of I2 is 86% on this outcome
- f. Imprecise confidence intervals

DISCUSIÓN

Esta revisión sistemática proporciona una visión completa y actual de los efectos del ejercicio aeróbico sobre los componentes del síndrome metabólico en la población geriátrica. Se encontró una disminución significativa en la glucosa en ayunas, la hemoglobina glicosilada, los triglicéridos, la PAS, la PAD y el aumento de los valores de HDL. Además, 4 de los 386 participantes en el estudio presentaron eventos adversos y 1 participante del grupo de intervención el evento fue grave (accidente cerebrovascular). Sin embargo, la mayoría de los resultados primarios evaluados tuvieron evidencia de certeza muy baja o baja, excepto la glucosa en ayunas y la presión arterial.

De la síntesis de 5 ECA hemos obtenido que los valores de glucosa disminuyeron con la práctica de ejercicio aeróbico, nuestros hallazgos fueron similares a los reportados por la Kumar et al.³⁹ en donde se evaluaron 11 ensayos clínicos con una población adulta de pacientes diabéticos, encontrando una disminución tanto en la glucosa en ayunas como en la hemoglobina glicosilada. Estos resultados pueden explicarse por el hecho de que una rutina de entrenamiento frecuente mejora el rendimiento hepático al reducir la acumulación de lípidos, mejorar la resistencia a la insulina en este órgano y disminuir la producción nocturna de glucosa hepática⁴⁰ junto con una mayor actividad de las enzimas mitocondriales (mejorando así la energía muscular)⁴¹.

Cuando la medición del control glucémico es con hemoglobina glicosilada, los resultados de la síntesis de 4 ECA en nuestra revisión, así como otras revisiones sistemáticas de similares características, son consistentes. Una revisión sistemática de Pan, et al⁴² con una población similar a la nuestra reportó resultados que el

ejercicio aeróbico supervisado tuvo un mayor efecto en la hemoglobina glicosilada en comparación con el ejercicio de resistencia o combinado. Además, un metaanálisis de Gao et al ⁴³ con 972 participantes informó una diferencia de medias de -0,46 en A1c a favor de la intervención.

El macronutriente utilizado para obtener energía depende de la duración e intensidad del entrenamiento: se utiliza más glucosa durante el ejercicio de alta intensidad, mientras que la oxidación de ácidos grasos aumenta durante el ejercicio de intensidad moderada ⁴⁴.

En cuanto al metabolismo lipídico, nuestra revisión sintetizó el resultado de 5 ECA, muchos de los estudios refuerzan la relación entre el ejercicio aeróbico y la tendencia a normalizar los valores de lípidos y lipoproteínas, demostrando que la intervención aumenta los valores de HDL y disminuye los triglicéridos. Estos resultados están respaldados por diferentes revisiones como Schwingshacklet al.⁴⁵, donde la práctica de diferentes tipos de ejercicio durante 8 semanas ayuda a mejorar todos los componentes de la dislipidemia en especial es ejercicio combinado. El aumento de HDL en el ejercicio podría explicarse por la asociación entre el ejercicio aeróbico y el aumento de la actividad de la lipoproteína lipasa, lo que se traduce en un aumento de la lipólisis de lipoproteínas ricas en triglicéridos, que puede ser un paso inicial en los niveles más altos de HDL sérico. Además de lo anterior, hay una reducción en la actividad de la lipasa hepática y la concentración sérica de proteína de transferencia de éster colesteroil (CETP), siendo esta última la que cataliza el flujo de transformación del colesterol HDL al colesterol VLDL y colesterol LDL ⁴⁶.

A partir de la síntesis de 4 ECA se informa que los valores de presión arterial

sistólica y diastólica disminuyen con el ejercicio aeróbico. En este sentido, Punia et al ⁴⁷ quienes evaluaron el efecto del ejercicio aeróbico en adultos de la India encontraron que disminuye significativamente la PAS y la PAD. El mecanismo por lo que esto sucede es dado por una disminución de los valores de presión arterial sistólica y diastólica en el período posterior al entrenamiento debido a una reducción de la resistencia vascular periférica ¹⁴, sin embargo otro estudio menciona que hasta ahora los mecanismos por los cuales el ejercicio reduce la presión arterial son inciertos, pero las diversas vías posibles incluyen la reducción de la inflamación, menos daño oxidativo, el control de la sensibilidad al sodio y la disminución de la rigidez arterial ⁴⁸.

Con respecto a los efectos adversos, sólo se encontró 1 evento adverso grave (accidente cerebrovascular) en 386 participantes. Acerca de, Church et al ⁴⁹ informaron en un ECA de 221 individuos con diferentes rutinas de entrenamiento, 5 eventos cardiovasculares ninguno relacionado con el ejercicio físico. A pesar de ello, se debe tener en cuenta que se han reportado mayores efectos adversos en adultos diabéticos mayores en estudios previos ⁵⁰. Esto puede explicarse por la fragilidad y mayor prevalencia de comorbilidades en esta población. Por lo tanto, los resultados deben considerarse con precaución ya que las edades medias de los ensayos estuvieron entre 60 y 70 años.

Teniendo en cuenta que la diabetes es uno de los principales problemas de salud pública ⁵¹, nuestro estudio muestra que una medida de bajo costo y relativamente fácil de implementar como el ejercicio aeróbico ayuda en gran medida a los componentes del síndrome metabólico en la población mayor. Su implantación en el sistema sanitario, como un programa dedicado a la actividad aeróbica,

potencialmente podría reducir significativamente la aparición de complicaciones, evitar el avance a corto plazo a un evento cardiovascular con mayor mortalidad con un alto riesgo de secuelas irreversibles y una mayor dependencia. Además, se pueden agregar los efectos beneficiosos indirectos que reducen en gran medida la fragilidad de este grupo de edad, sin embargo, debido a que los outcome estudios son subrogados, no se puede confirmar la relevancia clínica. Por último, y no menos importante, probablemente ayudaría a reducir la dosis de fármacos hipoglucemiantes e hipotensores, lo que podría traducirse en un menor coste en el mantenimiento de las enfermedades crónicas. Del mismo modo, nuestra relevancia radica en que, hasta donde sabemos, se trata de la primera revisión sistemática que analiza los efectos del ejercicio aeróbico sobre los componentes del síndrome metabólico en la población anteriormente mencionada, lo que ayudaría a orientar el manejo futuro e implementar este tipo de ejercicio en la práctica diaria de estos pacientes.

Limitaciones

Nuestra investigación tuvo algunas limitaciones. En primer lugar, hubo un alto porcentaje de estudios con riesgo alto o moderado de sesgo. En segundo lugar, las características de las intervenciones fueron heterogéneas, sin embargo, se realizó un análisis de subgrupos según el tiempo de intervención, la supervisión y la intensidad, que la mayoría no mostró diferencias, estos resultados deben considerarse con precaución debido al bajo número de ensayos. En tercer lugar, este estudio abarcó siete ECA, la mayoría de los cuales tuvieron un número relativamente bajo de participantes, aunque se realizó un análisis sensible excluyendo cada estudio, que no mostró diferencias. Y cuarto, no fue posible

evaluar el efecto específico de diferentes rutinas de ejercicio aeróbico porque en todos los ECA incluidos la intervención fue la misma (cinta de correr o caminar), pero se debe considerar que este tipo de entrenamiento es el más utilizado en el grupo de edad estudiado.

CONCLUSIONES

Entre los ensayos clínicos disponibles, que estudiaron el efecto del ejercicio aeróbico sobre los componentes del síndrome metabólico en adultos mayores con diagnóstico de DT2 en comparación con los controles sin ejercicio, encontramos una disminución en los valores de glucosa en ayunas, triglicéridos glicosilados de hemoglobina, PAS, PAD y una pequeña modificación de triglicéridos y HDL. Sin embargo, estos resultados deben ser interpretados con cautela debido a la baja relevancia clínica. A su vez, en la mayoría de los ensayos clínicos, los eventos adversos no se informaron durante las intervenciones, o fueron muy aislados, lo que dificultó su asociación con él. Por último, se recomienda realizar ensayos clínicos de mejor calidad metodológica. multicéntrico y con muestras más grandes para que pueda dar una correcta representación de los efectos del ejercicio aeróbico.

RECONOCIMIENTOS

Conflicto de interés

Todos los autores han declarado que no hay conflicto de intereses para esta revisión sistemática.

Contribuciones de Autores

Mercedes Miranda y Joshua Ramírez realizaron las búsquedas en la base de datos, el análisis de datos y la interpretación de los resultados. Miguel Cabanillas realizó

todos los análisis estadísticos de datos. Mercedes Miranda y Joshua Ramírez fueron los responsables de la preparación del manuscrito. Isabel Pinedo y José Luis Paz asesoraron durante la interpretación de datos y redacción de manuscritos. Todos los autores participaron en la concepción, el diseño y la interpretación de los datos. Todos los autores revisaron el manuscrito y aprobaron la versión final para su envío.

Rol del patrocinador

No hubo patrocinadores involucrados en el diseño del estudio, los métodos, el reclutamiento de sujetos, la recopilación de datos, el análisis o la preparación de este documento.

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ANEXOS

Anexo 1. Estrategia de búsqueda electrónica

Databases	Search strategy
Pubmed/ Medline	<p>#1 (“Diabetes mellitus”[MeSH] OR “Diabetes Mellitus Type 2”[tiab] OR “Diabetes Mellitus Noninsulin-Dependent”[tiab] OR “Diabetes Mellitus Non Insulin Dependent”[tiab] OR “Diabetes Mellitus Non-Insulin-Dependent”[tiab] OR “Non-Insulin-Dependent Diabetes Mellitus”[tiab] OR “Diabetes Mellitus Stable”[tiab] OR “Diabetes Mellitus Type II”[tiab] OR “NIDDM”[tiab] OR “Diabetes Mellitus Noninsulin Dependent”[tiab] OR “Diabetes Mellitus Slow-Onset”[tiab] OR “Type 2 Diabetes”[tiab])</p> <p>#2 (“exercise”[MeSH] OR “Exercises”[tiab] OR “Physical Activity”[tiab] OR “Activities, physical”[tiab] OR “activity, physical”[tiab] OR “physical activities”[tiab] OR “Exercise Physical”[tiab] OR “Exercises, physical”[tiab] OR “Physical Exercise”[tiab] OR “physical exercises”[tiab] OR “Aerobic</p>

	<p>Exercise"[tiab] OR "Aerobic Exercises"[tiab] OR "Exercises Aerobic"[tiab] OR "Exercise Training"[tiab] OR "Exercise Trainings"[tiab] OR "Training Exercise"[tiab] OR "Aerobic training"[tiab] OR "endurance training"[MeSH] OR "Training Endurance"[tiab] OR "Physical endurance"[tiab] OR "sports"[MeSH] OR "Sport"[tiab] OR "Athletic*"[tiab] OR "walking"[MeSH] OR "Ambulation"[tiab] OR "running"[MeSH] OR "Runnings"[tiab] OR "Swimming"[tiab] OR "Treadmill"[tiab] OR "Treadmill Test"[tiab] OR "Treadmill Tests"[tiab] OR "Jogging"[MeSH])</p> <p>#3 ("Randomized Controlled Trial"[PT] or "Randomized Controlled Trials as Topic"[Mesh] OR "Clinical Trial"[PT] OR "Clinical Trials as Topic"[Mesh] OR "Clinical Trial, Phase III"[PT] OR "Clinical Trial, Phase II"[PT] OR "Double-Blind Method"[Mesh] OR "Random Allocation"[Mesh] OR "Single-Blind Method"[Mesh] OR (random*[tiab]) OR ((randomized[tiab] OR randomised[tiab] OR clinical[tiab] OR control*[tiab]) AND trial[tiab]) OR ((singl*[tiab] OR doubl*[tiab] OR trebl*[tiab] OR tripl*[tiab]) AND (blind*[tiab] OR mask*[tiab])) OR ("Placebos"[Mesh] OR placebo*[tiab]) OR ("Cross-Over Studies"[Mesh]) OR ((crossover[tiab] OR cross-over[tiab] OR "cross over"[tiab]) AND (design*[tiab] OR study[tiab] OR studies[tiab] OR procedure*[tiab] OR trial*[tiab])))</p> <p>#4 #1 AND #2 AND #3</p>
<p>Scopus</p>	<p>#1 (TITLE-ABS-KEY("Exercise" OR "Exercises" OR "Aerobic training" OR "Physical Activity" OR "Physical Activities" OR "Physical Exercise" OR "Physical Exercises" OR "Aerobic Exercise" OR "Aerobic Exercises" OR "Exercise Training" OR "Exercise Trainings")) OR (TITLE-ABS-KEY("Endurance training" OR "Physical endurance")) OR (TITLE-ABS-KEY("Treadmill" OR "Treadmill Test" OR "Treadmill Tests")) OR (TITLE-ABS-KEY("Pools Swimming" OR "Swimming Pool")) OR (TITLE-ABS-KEY("Jogging")) OR (TITLE-ABS-KEY ("Sports" OR "Sport" OR "Athletics" OR "Athletic")) OR (TITLE-ABS-KEY("Walking" OR "Ambulation")) OR (TITLE-ABS-KEY("Running" OR "Runnings")) OR (TITLE-ABS-KEY("Jogging"))</p> <p>#2: TITLE-ABS-KEY ("Diabetes Mellitus Non Insulin Dependent" OR "Diabetes Mellitus Noninsulin Dependent" OR "Non Insulin Dependent Diabetes Mellitus" OR "Noninsulin Dependent Diabetes Mellitus" OR "Diabetes Mellitus Stable" OR "Stable Diabetes Mellitus" OR "NIDDM" OR "Diabetes Mellitus Slow Onset" OR "Slow Onset Diabetes Mellitus" OR "Type 2 Diabetes Mellitus" OR "Type 2 Diabetes" OR "Diabetes Mellitus Type 2" OR "Diabetes Type 2" OR "Diabetes Mellitus Type II" OR "Diabetes Type II" OR "Type II Diabetes Mellitus" OR "Type II Diabetes" OR "Diabetes mellitus 2" OR "Diabetes mellitus II")</p>

	<p>#3: ((TITLE-ABS-KEY ("randomized" OR "randomised" OR "clinical" OR "control*") AND TITLE-ABS-KEY ("trial")) OR (TITLE-ABS-KEY("singl*" OR "doubl*" OR "trebl*" OR "tripl*") AND TITLE-ABS-KEY("blind*" OR "mask*")) OR (TITLE-ABS-KEY("crossover" OR "cross-over" OR "cross over") AND TITLE-ABS-KEY("design*" OR "study" OR "studies" OR "procedure*" OR "trial*")) OR TITLE-ABS-KEY("Randomized Controlled Trial" OR "Randomized Controlled Trials as Topic" OR "Clinical Trial" OR "Clinical Trials as Topic" OR "Clinical Trial, Phase III" OR "Clinical Trial, Phase II" OR "Double-Blind Method" OR "Random Allocation" OR "Single-Blind Method" OR "random*" OR "placebo*"))</p> <p>#4 (LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2018) OR LIMIT-TO (PUBYEAR,2017) OR LIMIT-TO (PUBYEAR,2016) OR LIMIT-TO (PUBYEAR,2015) OR LIMIT-TO (PUBYEAR,2014) OR LIMIT-TO (PUBYEAR,2013) OR LIMIT-TO (PUBYEAR,2012) OR LIMIT-TO (PUBYEAR,2011) OR LIMIT-TO (PUBYEAR,2010))</p> <p>#5 (LIMIT-TO (DOCTYPE,"ar"))</p> <p>#6: #1 AND #2 AND #3 AND #4 AND 5</p>
<p>Web of science</p>	<p>#1: TS=("Exercise" OR "Exercises" OR "Aerobic training" OR "Physical Exercise" OR "Physical Exercises" OR "Aerobic Exercise" OR "Aerobic Exercises" OR "Exercise Training" OR "Exercise Trainings" OR "Endurance training" OR "Physical endurance" OR "Treadmill" OR "Treadmill Test" OR "Treadmill Tests" OR "Pools Swimming" OR "Swimming Pool" OR "Jogging" OR "Sports" OR "Sport" OR "Athletics" OR "Athletic" OR "Walking" OR "Ambulation" OR "Running" OR "Runnings")</p> <p>#2: TS=("Diabetes Mellitus Non Insulin Dependent" OR "Diabetes Mellitus Noninsulin Dependent" OR "Non Insulin Dependent Diabetes Mellitus" OR "Noninsulin Dependent Diabetes Mellitus" OR "Diabetes Mellitus Stable" OR "Stable Diabetes Mellitus" OR "NIDDM" OR "Diabetes Mellitus Slow Onset" OR "Slow Onset Diabetes Mellitus" OR "Type 2 Diabetes Mellitus" OR "Type 2 Diabetes" OR "Diabetes Mellitus Type 2" OR "Diabetes Type 2" OR "Diabetes Mellitus Type II" OR "Diabetes Type II" OR "Type II Diabetes Mellitus" OR "Type II Diabetes" OR "Diabetes mellitus 2" OR "Diabetes mellitus II")</p> <p>#3: TS=(randomized OR randomised OR clinical OR control*) AND TS=(trial)</p> <p>#4: TS=(singl* OR doubl* OR trebl* OR tripl*) AND TS=(blind* OR mask*)</p>

	<p>#5: TS=(crossover OR cross-over OR "cross over") AND TS=(design* OR study OR studies OR procedure* OR trial*)</p> <p>#6: TS=("Randomized Controlled Trial" OR "Randomized Controlled Trials as Topic" OR "Clinical Trial" OR "Clinical Trials as Topic" OR "Clinical Trial, Phase III" OR "Clinical Trial, Phase II" OR "Double-Blind Method" OR "Random Allocation" OR "Single-Blind Method" OR random* OR placebo*)</p> <p>#7: #3 OR #4 OR #5 OR #6</p> <p>#8: #1 AND #2 AND #7</p>
<p>Cochrane</p>	<p>#1 MeSH descriptor: [Exercise] explode all trees</p> <p>#2 ("Exercises" OR "Physical Activity" OR "Activities Physical" OR "Activity Physical" OR "Physical Activities" OR "Exercise Physical" OR "Exercises Physical" OR "Physical Exercise" OR "Physical Exercises" OR "Exercise Aerobic" OR "Aerobic Exercise" OR "Aerobic Exercises" OR "Exercises Aerobic" OR "Exercise Training" OR "Exercise Trainings" OR "Training Exercise" OR "Trainings Exercise" OR "Aerobic training"):ti,ab,kw</p> <p>#3 MeSH descriptor: [Endurance Training] explode all trees</p> <p>#4 ("Training Endurance" OR "Physical endurance"):ti,ab,kw</p> <p>#5 MeSH descriptor: [Sports] explode all trees</p> <p>#6 (sport OR athletics OR athletic):ti,ab,kw</p> <p>#7 MeSH descriptor: [Swimming] explode all trees</p> <p>#8 (swimming):ti,ab,kw</p>

#9 MeSH descriptor: [Walking] explode all trees

#10 (ambulation):ti,ab,kw

#11 MeSH descriptor: [Running] explode all trees

#12 (runnings):ti,ab,kw

#13 ("treadmill" OR "treadmill test" OR "test, treadmill" OR "treadmill tests" OR "jogging"):ti,ab,kw

#14 MeSH descriptor: [Diabetes Mellitus, Type 2] explode all trees

#15 ("Diabetes Mellitus, Type 2" OR "Diabetes Mellitus, Noninsulin-Dependent" OR "Diabetes Mellitus, Non Insulin Dependent" OR "Diabetes Mellitus, Non-Insulin-Dependent" OR "Non-Insulin-Dependent Diabetes Mellitus" OR "Diabetes Mellitus, Stable" OR "Stable Diabetes Mellitus" OR "Diabetes Mellitus, Type II" OR "NIDDM" OR "Diabetes Mellitus, Noninsulin Dependent" OR "Diabetes Mellitus, Slow-Onset" OR "Diabetes Mellitus, Slow Onset" OR "Slow-Onset Diabetes Mellitus" OR "Type 2 Diabetes Mellitus" OR "Noninsulin-Dependent Diabetes Mellitus" OR "Noninsulin Dependent Diabetes Mellitus" OR "Type 2 Diabetes" OR "Diabetes, Type 2"):ti,ab,kw

#16 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13) AND (#14 OR #15)

#17 ("Randomized Controlled Trial" OR "Clinical Trial" OR "Clinical Trial, Phase III" OR "Clinical Trial, Phase II"):pt

	<p>#18 MeSH descriptor: [Randomized Controlled Trials as Topic] explode all trees</p> <p>#19 MeSH descriptor: [Clinical Trials as Topic] explode all trees</p> <p>#20 MeSH descriptor: [Double-Blind Method] explode all trees</p> <p>#21 MeSH descriptor: [Random Allocation] explode all trees</p> <p>#22 MeSH descriptor: [Random Allocation] explode all trees</p> <p>#23 MeSH descriptor: [Placebos] explode all trees</p> <p>#24 MeSH descriptor: [Cross-Over Studies] explode all trees</p> <p>#25 (random* OR placebo*):ti,ab,kw</p> <p>#26 (((randomized OR randomised OR clinical OR control*) AND trial)):ti,ab,kw</p> <p>#27 (((singl* OR doubl* OR trebl* OR tripl*) AND (blind* OR mask*)):ti,ab,kw</p> <p>#28 (((crossover OR cross-over OR "cross over") AND (design* OR study OR studies OR procedure* OR trial*)):ti,ab,kw</p> <p>#29 #16 AND (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28)</p>
Google Scholar	("Exercise" OR "Ejercicio" OR "aerobic training" OR "ejercicio aeróbico" OR "Sport" OR "Deporte" OR "Walking" OR "caminata OR "running" OR "carrera") AND ("Diabetes mellitus type 2" OR "Type 2 diabetes")

Anexo 2. Lista de estudios excluidos después de la revisión del texto completo

CITE	FIRST AUTHOR	TITLE	YEAR	REASON FOR EXCLUSION
1	Serin	The Effect of the Transtheoretical Model Based Walking Exercise Training and Follow-Up on Improving Exercise Behavior and Metabolic Control in Patients with Type 2 Diabetes	2020	not elderly patients

2	Adeniyi	Neuromusculoskeletal disorders in patients with type 2 diabetes mellitus: Outcome of a twelve-week therapeutic exercise programme	2010	not elderly patients
3	Albu	Metabolic changes following a 1-year diet and exercise intervention in patients with type 2 diabetes	2010	not elderly patients
4	Balducci	Anti-inflammatory effect of exercise training in subjects with type 2 diabetes and the metabolic syndrome is dependent on exercise modalities and independent of weight loss	2010	not elderly patients
5	Chen	Effect of T'ai Chi exercise on biochemical profiles and oxidative stress indicators in obese patients with type 2 diabetes	2010	not elderly patients
6	Gram	Effects of nordic walking and exercise in type 2 diabetes mellitus: A randomized controlled trial	2010	not elderly patients
7	Kadoglou	Exercise ameliorates serum MMP-9 and TIMP-2 levels in patients with type 2 diabetes	2010	not elderly patients
8	Koo	The effects of total energy expenditure from all levels of physical activity vs. physical activity energy expenditure from moderate-to-vigorous activity on visceral fat and insulin sensitivity in obese Type 2 diabetic women	2010	not elderly patients
9	Larose	Effect of exercise training on physical fitness in type II diabetes mellitus	2010	not elderly patients
10	Meex	Restoration of muscle mitochondrial function and metabolic flexibility in type 2 diabetes by exercise training is paralleled by increased myocellular fat storage and improved insulin sensitivity	2010	without control group
11	Negri	Supervised walking groups to increase physical activity in type 2 diabetic patients	2010	not elderly patients
12	Reid	Effects of aerobic exercise, resistance exercise or both, on patient-reported health status and well-being in type 2 diabetes mellitus: A randomised trial	2010	not elderly patients

13	Sixt	Long- but not short-term multifactorial intervention with focus on exercise training improves coronary endothelial dysfunction in diabetes mellitus type 2 and coronary artery disease	2010	not elderly patients
14	Solomon	Improved pancreatic β -cell function in type 2 diabetic patients after lifestyle-induced weight loss is related to glucose-dependent insulinotropic polypeptide	2010	without control group
15	Yavari	The effect of aerobic exercise on glycosylated hemoglobin values in type 2 diabetes patients	2010	not elderly patients
16	Andrews	Diet or diet plus physical activity versus usual care in patients with newly diagnosed type 2 diabetes: the Early ACTID randomised controlled trial	2011	not elderly patients
17	Backx	The effect of a supported exercise programme in patients with newly diagnosed Type 2 diabetes: a pilot study	2011	not elderly patients
18	Barragan	Effects of exercise on glycosylated hemoglobin type 2 diabetic patients from the West of Mexico	2011	not available
19	Behboudi	Effects of aerobic exercise and whole body vibration on glycaemia control in type 2 diabetic males	2011	not elderly patients
20	Bello	Effects of aerobic exercise on selected physiological parameters and quality of life in patients with type 2 diabetes mellitus	2011	not elderly patients
21	Ferrer	[Benefits of a home-based physical exercise program in elderly subjects with type 2 diabetes mellitus]	2011	not intervention
22	Hare	Application of an Exercise Intervention on the Evolution of Diastolic Dysfunction in Patients With Diabetes Mellitus Efficacy and Effectiveness	2011	not elderly patients
23	Huebschmann	Exercise attenuates the premature cardiovascular aging effects of type 2 diabetes mellitus	2011	not clinical trial
24	Jorge	The effects of aerobic, resistance, and combined exercise on metabolic control, inflammatory markers, adipocytokines, and muscle insulin signaling in patients with type 2 diabetes mellitus	2011	not elderly patients

25	Kurban	Effect of Chronic Regular Exercise on Serum Ischemia-Modified Albumin Levels and Oxidative Stress in Type 2 Diabetes Mellitus	2011	not elderly patients
26	Larose	Associations between physical fitness and HbA(1c) in type 2 diabetes mellitus	2011	not elderly patients
27	Lucotti	Aerobic and resistance training effects compared to aerobic training alone in obese type 2 diabetic patients on diet treatment	2011	not elderly patients
28	Moghaddam	Training increases peroxiredoxin 2 contents in the erythrocytes of overweight/obese men suffering from type 2 diabetes	2011	not elderly patients
29	Nicolucci	Improvement of quality of life with supervised exercise training in subjects with type 2 diabetes mellitus	2011	not clinical trial
30	Schneider	Design and methods for a pilot randomized clinical trial involving exercise and behavioral activation to treat comorbid type 2 diabetes and major depressive disorder	2011	not elderly patients
31	Schultz	Lifestyle change diminishes a hypertensive response to exercise in type 2 diabetes	2011	not elderly patients
32	Snel	Immediate and long-term effects of addition of exercise to a 16-week very low calorie diet on low-grade inflammation in obese, insulin-dependent type 2 diabetic patients	2011	not elderly patients
33	Stewart	Exercise Training Fails to Reduce Blood Pressure in Type 2 Diabetes: A Randomized Controlled Trial Stewart	2011	not clinical trial
34	Teixeira	Regular physical exercise training assists in preventing type 2 diabetes development: focus on its antioxidant and anti-inflammatory properties	2011	not clinical trial
35	Wang	SKELETAL MUSCLE AND SUBCUTANEOUS ADIPOSE TISSUE ADAPTATIONS TO POWER TRAINING IN OLDER ADULTS WITH TYPE 2 DIABETES: A DOUBLE BLIND, RANDOMIZED SHAM-EXERCISE CONTROLLED TRIAL	2011	not available
36	Agula	Efecto del ejercicio físico en el control metabólico y en factores de riesgo de pacientes con diabetes mellitus tipo 2: estudio cuasi experimental	2012	not elderly patients

37	Ahn	Effects of Tai Chi Exercise on glucose control, neuropathy scores, balance, and quality of life in patients with type 2 diabetes and neuropathy	2012	not elderly patients
38	Balducci	Changes in physical fitness predict improvements in modifiable cardiovascular risk factors independently of body weight loss in subjects with type 2 diabetes participating in the Italian Diabetes and Exercise Study (IDES)	2012	not elderly patients
39	Barone	A randomized trial of exercise for blood pressure reduction in type 2 diabetes: effect on flow-mediated dilation and circulating biomarkers of endothelial function	2012	not elderly patients
40	Choi	Effects of exercise on sRAGE levels and cardiometabolic risk factors in patients with type 2 diabetes: a randomized controlled trial	2012	not elderly patients
41	Cooper	Sedentary time, breaks in sedentary time and metabolic variables in people with newly diagnosed type 2 diabetes	2012	not elderly patients
42	de Oliveira	The effect of different training programs on antioxidant status, oxidative stress, and metabolic control in type 2 diabetes	2012	not elderly patients
43	Dobrosielski	Effect of exercise on blood pressure in type 2 diabetes: a randomized controlled trial	2012	not elderly patients
44	Florez	Impact of lifestyle intervention and metformin on health-related quality of life: the diabetes prevention program randomized trial	2012	not elderly patients
45	Gallagher	A randomised trial of a weight loss intervention for overweight and obese people diagnosed with coronary heart disease and/or type 2 diabetes	2012	not elderly patients
46	Gillen	Acute high-intensity interval exercise reduces the postprandial glucose response and prevalence of hyperglycaemia in patients with type 2 diabetes	2012	no outcome
47	Hajjhasani,	Effects of eccentric and concentric exercises on some blood biochemical parameters in patients with type 2 diabetes	2012	not elderly patients
48	Lijima	Lower physical activity is a strong predictor of cardiovascular events in elderly patients with type 2 diabetes mellitus beyond	2012	not clinical trial

		traditional risk factors: the Japanese Elderly Diabetes Intervention Trial		
49	Jung	Effects of aerobic exercise intensity on abdominal and thigh adipose tissue and skeletal muscle attenuation in overweight women with type 2 diabetes mellitus	2012	not elderly patients
50	Kadoglou	The impact of aerobic exercise training on novel adipokines, apelin and ghrelin, in patients with type 2 diabetes	2012	not elderly patients
51	Karstoft	The effects and physiological mechanisms of free-living interval-walking training on glycaemic control in type 2 diabetes patients: a randomised, controlled trial	2012	not elderly patients
52	Mackenzie	Intermittent exercise with and without hypoxia improves insulin sensitivity in individuals with type 2 diabetes	2012	not elderly patients
53	Marquez	El ejercicio en el tratamiento de la diabetes mellitus tipo 2	2012	not clinical trial
54	Nitert	Impact of an exercise intervention on DNA methylation in skeletal muscle from first-degree relatives of patients with type 2 diabetes	2012	not elderly patients
55	Sazlina	Promoting physical activity in sedentary elderly Malays with type 2 diabetes: a protocol for randomised controlled trial	2012	not clinical trial
56	Shaw	Prolonged exercise training increases intramuscular lipid content and perilipin 2 expression in type I muscle fibers of patients with type 2 diabetes	2012	without control group
57	Simmonds	Preliminary findings in the heart rate variability and haemorheology response to varied frequency and duration of walking in women 65-74 yr with type 2 diabetes	2012	without control group
58	Snel	Effects of adding exercise to a 16-week very low-calorie diet in obese, insulin-dependent type 2 diabetes mellitus patients	2012	not elderly patients
59	Snel	Quality of life in type 2 diabetes mellitus after a very low calorie diet and exercise	2012	no outcome
60	Swift	Effect of exercise training modality on C-reactive protein in type 2 diabetes	2012	not elderly patients

61	Swift	The effect of exercise training modality on serum brain derived neurotrophic factor levels in individuals with type 2 diabetes	2012	not elderly patients
62	Teixeira	Regular physical exercise as a strategy to improve antioxidant and anti-inflammatory status: benefits in type 2 diabetes mellitus	2012	not clinical trial
63	van der Heijden	Testing the effectiveness of a self-efficacy based exercise intervention for inactive people with type 2 diabetes mellitus: design of a controlled clinical trial	2012	not elderly patients
64	Van dijk	Both resistance- and endurance-type exercise reduce the prevalence of hyperglycaemia in individuals with impaired glucose tolerance and in insulin-treated and non-insulin-treated type 2 diabetic patients	2012	not intervention
65	Yavari	EFFECT OF AEROBIC EXERCISE, RESISTANCE TRAINING OR COMBINED TRAINING ON GLYCAEMIC CONTROL AND CARDIOVASCULAR RISK FACTORS IN PATIENTS WITH TYPE 2 DIABETES	2012	not elderly patients
66	Abd	Impact of moderate versus mild aerobic exercise training on inflammatory cytokines in obese type 2 diabetic patients: a randomized clinical trial	2013	not elderly patients
67	Adeniyi	Time course of improvement of metabolic parameters after a 12 week physical exercise programme in patients with type 2 diabetes: the influence of gender in a Nigerian population	2013	not elderly patients
68	Ahmad	Influence of 3 months endurance training on red cell deformability in non insulin dependent type 2 diabetes mellitus patients	2013	not elderly patients
69	Barakat	Changes in physical activity and modelled cardiovascular risk following diagnosis of diabetes: 1-year results from the ADDITION-Cambridge trial cohort	2013	not elderly patients
70	Beverly	Impact of Reinforcement of Diabetes Self-Care on Poorly Controlled Diabetes A Randomized Controlled Trial	2013	not elderly patients

71	Blomster	The influence of physical activity on vascular complications and mortality in patients with type 2 diabetes mellitus	2013	no outcome
72	de la Torre	Early management of type 2 diabetes based on a SMBG strategy: the way to diabetes regression-the St Carlos study	2013	not elderly patients
73	Dobrosielski	Effect of exercise on abdominal fat loss in men and women with and without type 2 diabetes	2013	not elderly patients
74	Espeland	Intensive weight loss intervention in older individuals: results from the Action for Health in Diabetes Type 2 diabetes mellitus trial	2013	not intervention
75	Fiocco	The effects of an exercise and lifestyle intervention program on cardiovascular, metabolic factors and cognitive performance in middle-aged adults with type ii diabetes: A pilot study	2013	not elderly patients
76	Foster	A randomized comparison of a commercially available portion-controlled weight-loss intervention with a diabetes self-management education program	2013	not elderly patients
77	Fritz	Effects of Nordic walking on cardiovascular risk factors in overweight individuals with type 2 diabetes, impaired or normal glucose tolerance	2013	not elderly patients
78	de la Torre	Early management of type 2 diabetes based on a SMBG strategy: The way to diabetes regression - The St Carlos study: A 3-year, prospective, randomized, clinic-based, interventional study with parallel groups	2013	not elderly patients
79	Jakicic	Four-year change in cardiorespiratory fitness and influence on glycemic control in adults with type 2 diabetes in a randomized trial: the Look AHEAD Trial	2013	not elderly patients
80	Johannsen	Determinants of the Changes in Glycemic Control with Exercise Training in Type 2 Diabetes: A Randomized Trial	2013	not elderly patients
81	Karstoft	The Effects of Free-Living Interval Walking Training on Glycemic Control, Body Composition, and Physical Fitness in Type 2 Diabetic Patients A randomized, controlled trial	2013	not elderly patients

82	Liu	The effect of Tai Chi on health-related quality of life in people with elevated blood glucose or diabetes: A randomized controlled trial	2013	not elderly patients
83	Mavros	Changes in insulin resistance and HbA1c are related to exercise-mediated changes in body composition in older adults with type 2 diabetes: interim outcomes from the GREAT2DO trial	2013	not intervention
84	Montero	Effects of exercise training on arterial function in type 2 diabetes mellitus	2013	not clinical trial
85	Mueller	Weight-bearing versus nonweight-bearing exercise for persons with diabetes and peripheral neuropathy: A randomized controlled trial	2013	not elderly patients
86	Saha	A culturally adapted lifestyle intervention addressing a Middle Eastern immigrant population at risk of diabetes, the MEDIM (impact of Migration and Ethnicity on Diabetes In Malmö): study protocol for a randomized controlled trial	2013	not clinical trial
87	Senechal	Changes in body fat distribution and fitness are associated with changes in hemoglobin A1c after 9 months of exercise training: results from the HART-D study	2013	not elderly patients
88	Solomon	The influence of hyperglycemia on the therapeutic effect of exercise on glycemic control in patients with type 2 diabetes mellitus	2013	not elderly patients
89	Sukala	Exercise improves quality of life in indigenous Polynesian peoples with type 2 diabetes and visceral obesity	2013	not elderly patients
90	Terada	Feasibility and preliminary efficacy of high intensity interval training in type 2 diabetes	2013	without control group
91	Terada	Exploring the variability in acute glycemic responses to exercise in type 2 diabetes	2013	without control group
92	Tomar	Effects of a 12-week aerobic training on glycemic control in type 2 diabetes mellitus male patients	2013	not elderly patients

93	Wenning	Endurance exercise alters cellular immune status and resistin concentrations in men suffering from non-insulin-dependent type 2 diabetes	2013	not elderly patients
94	Arslan	Effect of Aerobic Exercise Training on MDA and TNF- α Levels in Patients with Type 2 Diabetes Mellitus	2014	not elderly patients
95	Avery	Movement as Medicine for Type 2 Diabetes: protocol for an open pilot study and external pilot clustered randomised controlled trial to assess acceptability, feasibility and fidelity of a multifaceted behavioural intervention targeting physical activity in primary care	2014	not clinical trial
96	Balducci	Physical exercise as therapy for type 2 diabetes mellitus	2014	not clinical trial
97	Bello	The Effect of a Long-Term, Community-Based Exercise Program on Bone Mineral Density in Postmenopausal Women with Pre-Diabetes and Type 2 Diabetes	2014	not elderly patients
98	Clarke	The INSPIRED study: A randomised controlled trial of the Whole Person Model of disease self-management for people with type 2 diabetes	2014	not elderly patients
99	Cooper	Association between objectively assessed sedentary time and physical activity with metabolic risk factors among people with recently diagnosed type 2 diabetes	2014	not elderly patients
100	Dasgupta	Step Monitoring to improve ARTERial health (SMARTER) through step count prescription in type 2 diabetes and hypertension: Trial design and methods	2014	not clinical trial
101	de souza	Positive effects of football on fitness, lipid profile, and insulin resistance in Brazilian patients with type 2 diabetes	2014	not elderly patients
102	Earnest	Aerobic and strength training in concomitant metabolic syndrome and type 2 diabetes	2014	not elderly patients
103	Espeland	Long-term impact of behavioral weight loss intervention on cognitive function	2014	not elderly patients

104	Falconer	Sedentary time and markers of inflammation in people with newly diagnosed type 2 diabetes	2014	not elderly patients
105	Gallagher	Changes in adipose tissue depots and metabolic markers following a 1-year diet and exercise intervention in overweight and obese patients with type 2 diabetes	2014	not elderly patients
106	Gibbs	Effect of improved fitness beyond weight loss on cardiovascular risk factors in individuals with type 2 diabetes in the Look AHEAD study	2014	not elderly patients
107	Griffin	Multiple behaviour change intervention and outcomes in recently diagnosed type 2 diabetes: the ADDITION-Plus randomised controlled trial	2014	not elderly patients
108	Guglani	Effect of progressive pedometer based walking intervention on quality of life and general well being among patients with type 2 diabetes	2014	not elderly patients
109	Hollekim	High-intensity interval exercise effectively improves cardiac function in patients with type 2 diabetes mellitus and diastolic dysfunction: a randomized controlled trial	2014	not elderly patients
110	Kaizu	Impact of leisure-time physical activity on glycemic control and cardiovascular risk factors in Japanese patients with type 2 diabetes mellitus: The Fukuoka Diabetes Registry	2014	not elderly patients
111	Kim	Effect of different training mode on Interleukin-6 (IL-6) and C-reactive protein (CRP) in type 2 diabetes mellitus (T2DM) patients	2014	not elderly patients
112	Krause	The effects of aerobic exercise training at two different intensities in obesity and type 2 diabetes: implications for oxidative stress, low-grade inflammation and nitric oxide production	2014	not elderly patients
113	Lee	The Effects of 12 Weeks Regular Aerobic Exercise on Brain-derived Neurotrophic Factor and Inflammatory Factors in Juvenile Obesity and Type 2 Diabetes Mellitus	2014	not elderly patients

114	Mangeri	A standard ballroom and Latin dance program to improve fitness and adherence to physical activity in individuals with type 2 diabetes and in obesity	2014	not elderly patients
115	Mensberg	Near-Normalization of Glycemic Control in Patients with Type 2 Diabetes with a Glucagon-like Peptide-1 Receptor Agonist in Combination with Exercise Training: A Randomized, Double-Blinded, Placebo-Controlled Clinical Trial	2014	without control group
116	Mitranum	Continuous vs interval training on glycemic control and macro- and microvascular reactivity in type 2 diabetic patients	2014	not elderly patients
117	Morrison	Exercise improves gait, reaction time and postural stability in older adults with type 2 diabetes and neuropathy	2014	not elderly patients
118	Phillips	A comparison of the effects of aerobic and intense exercise on the type 2 diabetes mellitus risk marker adipokines, adiponectin and retinol binding protein-4	2014	not clinical trial
119	Sacre	A six-month exercise intervention in subclinical diabetic heart disease: effects on exercise capacity, autonomic and myocardial function	2014	not elderly patients
120	Singleton	Exercise increases cutaneous nerve density in diabetic patients without neuropathy	2014	not elderly patients
121	Subramanian	Physio ball exercises on obesity and type II diabetes	2014	not available
122	Subramanian	Effects of Physioball exercises on glycemic control and quality life of Type II diabetic patients	2014	not elderly patients
123	Thompson	Effect of diet or diet plus physical activity versus usual care on inflammatory markers in patients with newly diagnosed type 2 diabetes: the Early ACTivity in Diabetes (ACTID) randomized, controlled trial	2014	not elderly patients
124	Yan	Effect of Aerobic Training on Glucose Control and Blood Pressure in T2DDM East African Males	2014	not elderly patients
125	Ades	Remission of Recently Diagnosed Type 2 Diabetes Mellitus With Weight Loss and Exercise	2015	not elderly patients

126	Ades	A lifestyle program of exercise and weight loss is effective in preventing and treating type 2 diabetes mellitus: why are programs not more available?	2015	not clinical trial
127	Al Shreef	Bone metabolism and hand grip strength response to aerobic versus resistance exercise training in non-insulin dependent diabetic patients	2015	not elderly patients
128	Balducci	Volume-dependent effect of supervised exercise training on fatty liver and visceral adiposity index in subjects with type 2 diabetes The Italian Diabetes Exercise Study (IDES)	2015	not elderly patients
129	Beavers	Body weight dynamics following intentional weight loss and physical performance: the Look AHEAD Movement and Memory Study	2015	not elderly patients
130	Byrkjeland	Effects of exercise training on HbA1c and VO2peak in patients with type 2 diabetes and coronary artery disease: A randomised clinical trial	2015	not elderly patients
131	Climie	Exercise excess pressure and exercise-induced albuminuria in patients with type 2 diabetes mellitus	2015	not elderly patients
132	da Silva	Impact of the activation of intention to perform physical activity in type II diabetics: a randomized clinical trial	2015	not elderly patients
133	Dede	Influence of Exercise on Leptin, Adiponectin and Quality of Life in Type 2 Diabetics	2015	not elderly patients
134	Emerenziani	Effects of Aerobic Exercise Based upon Heart Rate at Aerobic Threshold in Obese Elderly Subjects with Type 2 Diabetes	2015	not elderly patients
135	Fex	Effect of Elliptical High Intensity Interval Training on Metabolic Risk Factor in Pre- and Type 2 Diabetes Patients: A Pilot Study	2015	not elderly patients
136	Green	Cardiovascular control during exercise in type 2 diabetes mellitus	2015	not clinical trial
137	Hamasaki	Daily physical activity assessed by a triaxial accelerometer is beneficially associated with waist circumference, serum triglycerides, and insulin resistance in Japanese patients with prediabetes or untreated early type 2 diabetes	2015	not elderly patients

138	Higgins	Heterogeneous responses of personalised high intensity interval training on type 2 diabetes mellitus and cardiovascular disease risk in young healthy adults	2015	not elderly patients
139	Johnson	Increase in Daily Steps After an Exercise Specialist Led Lifestyle Intervention for Adults With Type 2 Diabetes In Primary Care: A Controlled Implementation Trial	2015	not elderly patients
140	Jung	Comparison of the effects of Korean mindfulness-based stress reduction, walking, and patient education in diabetes mellitus	2015	not elderly patients
141	Kasumov	Improved insulin sensitivity after exercise training is linked to reduced plasma C14:0 ceramide in obesity and type 2 diabetes	2015	not elderly patients
142	Kluding	Safety of aerobic exercise in people with diabetic peripheral neuropathy: single-group clinical trial	2015	not elderly patients
143	Lee	An investigation and comparison of the effectiveness of different exercise programmes in improving glucose metabolism and pancreatic β cell function of type 2 diabetes patients	2015	not elderly patients
144	Maharaj	The effect of rebound exercise and treadmill walking on the quality of life for patients with non-insulin-dependent type 2 diabetes	2015	not elderly patients
145	Mobasseri	Effect of a long-term regular physical activity on hypertension and body mass index in type 2 diabetes patients	2015	not elderly patients
146	Njerve	Effects of 12 months exercise intervention on adipose tissue expression of chemokines in patients with type 2 diabetes and stable coronary artery disease: a substudy of a randomized controlled trial (RCT)	2015	not elderly patients
147	Nylen	Enhanced fitness and renal function in Type 2 diabetes	2015	not elderly patients
148	Olson	Impact of a brief intervention on self-regulation, self-efficacy and physical activity in older adults with type 2 diabetes	2015	not elderly patients
149	Poblete	Effects of high intensity interval training versus moderate intensity continuous training on the reduction of oxidative stress in type 2 diabetic adult patients: CAT	2015	not elderly patients

150	Ring	Influence of physical activity and gender on arterial function in type 2 diabetes, normal and impaired glucose tolerance	2015	not elderly patients
151	Senechal	Association between Changes in Muscle Quality with Exercise Training and Changes in Cardiorespiratory Fitness Measures in Individuals with Type 2 Diabetes Mellitus: Results from the HART-D Study	2015	not elderly patients
152	Sentinelli	Positive effects of Nordic Walking on anthropometric and metabolic variables in women with type 2 diabetes mellitus	2015	not elderly patients
153	Stegen	Aerobic and resistance training do not influence plasma carnosinase content or activity in type 2 diabetes	2015	not elderly patients
154	Stephens	Resistance to the beneficial effects of exercise in type 2 diabetes: are some individuals programmed to fail?	2015	not elderly patients
155	Steurer	[Endurance training and walking improve blood glucose metabolism in type 2 diabetes mellitus]	2015	not available
156	Subramanian	Aerobic exercises on type II diabetic with hypertension	2015	not elderly patients
157	Teychenne	Adoption and maintenance of gym-based strength training in the community setting in adults with excess weight or type 2 diabetes: a randomized controlled trial	2015	not elderly patients
158	Tsai	Brain-derived neurotrophic factor correlated with muscle strength in subjects undergoing stationary bicycle exercise training	2015	not elderly patients
159	Alghadir	Cellular fibronectin response to supervised moderate aerobic training in patients with type 2 diabetes	2016	not elderly patients
160	Assad	Effectiveness of a Lifestyle Intervention in Patients with Type 2 Diabetes: The Physical Activity and Nutrition for Diabetes in Alberta (PANDA) Trial	2016	not elderly patients
161	Bener	The role of vitamin D, obesity and physical exercise in regulation of glycemia in Type 2 Diabetes Mellitus patients	2016	not elderly patients
162	Bentley	Feasibility study of portable technology for weight loss and HbA1c control in type 2 diabetes	2016	not elderly patients

163	Cassidy	High intensity intermittent exercise improves cardiac structure and function and reduces liver fat in patients with type 2 diabetes: a randomised controlled trial	2016	not elderly patients
164	Cox	Glycemic load, exercise, and monitoring blood glucose (GEM): A paradigm shift in the treatment of type 2 diabetes mellitus	2016	not elderly patients
165	Dadgostar	Supervised group-exercise therapy versus home-based exercise therapy: Their effects on Quality of Life and cardiovascular risk factors in women with type 2 diabetes	2016	not elderly patients
166	Deguchi	Acute effect of fast walking on postprandial blood glucose control in type 2 diabetes	2016	not elderly patients
167	Delevatti	Glucose control can be similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial	2016	not elderly patients
168	Delevatti	Glycemic reductions following water- and land-based exercise in patients with type 2 diabetes mellitus	2016	not elderly patients
169	Gamiochipi	Effect of an intensive metabolic control lifestyle intervention in type-2 diabetes patients	2016	not elderly patients
170	Hollekim	Exercise Training Normalizes Timing of Left Ventricular Untwist Rate, but Not Peak Untwist Rate, in Individuals with Type 2 Diabetes and Diastolic Dysfunction: A Pilot Study	2016	not elderly patients
171	Maillard	High-intensity interval training reduces abdominal fat mass in postmenopausal women with type 2 diabetes	2016	without control group
172	Mehdizadeh	Investigation of Plasma Visfatin Changes in Women with Type 2 Diabetes followed by Endurance, Resistance and Combined Exercise: The Role of Lipid Profile, Glycemic Indices and Insulin Resistance	2016	not elderly patients
173	Miyauchi	Exercise Therapy for Management of Type 2 Diabetes Mellitus: Superior Efficacy of Activity Monitors over Pedometers	2016	not elderly patients

174	Moosavi	The effect of regular aerobic exercise on plasma levels of 25-hydroxy Vitamin D and insulin resistance in hypertensive postmenopausal women with type 2 diabetes	2016	not available
175	Mousavian	Changes in some of the indicators of liver inflammation and cardiovascular risk factors during a term of synthetic aerobic exercise of diabetic women	2016	not elderly patients
176	Myette	The Effect of Exercise with or Without Metformin on Glucose Profiles in Type 2 Diabetes: A Pilot Study	2016	not elderly patients
177	Picone	SIX MONTHS EXERCISE INTERVENTION SIGNIFICANTLY IMPROVES ALBUMIN-CREATININE RATIO IN PATIENTS WITH TYPE 2 DIABETES: A RANDOMISED CONTROLLED TRIAL	2016	not intervention
178	Revdal	Can Time Efficient Exercise Improve Cardiometabolic Risk Factors in Type 2 Diabetes? A Pilot Study	2016	not elderly patients
179	Sobhanipour	A comparative study on the effect of endurance and resistance training on angiogenesis factors in elderly diabetic patients	2016	not elderly patients
180	Steidle	Does exercise training impact clock genes in patients with coronary artery disease and type 2 diabetes mellitus?	2016	not elderly patients
181	Terada	Targeting specific interstitial glycemic parameters with high-intensity interval exercise and fasted-state exercise in type 2 diabetes	2016	not elderly patients
182	Wagner	Improvement of insulin sensitivity in response to exercise training in type 2 diabetes mellitus is associated with vascular endothelial growth factor A expression	2016	not elderly patients
183	AminiLari	The Effect of 12 Weeks Aerobic, Resistance, and Combined Exercises on Omentin-1 Levels and Insulin Resistance among Type 2 Diabetic Middle-Aged Women	2017	not elderly patients
184	Bellia	Exercise individualized by TRIMPI method reduces arterial stiffness in early onset type 2 diabetic patients: A randomized controlled trial with aerobic interval training	2017	not elderly patients

185	Bratseth	Procoagulant activity in patients with combined type 2 diabetes and coronary artery disease: No effects of long-term exercise training	2017	not elderly patients
186	Byrkjeland	Reduced endothelial activation after exercise is associated with improved HbA(1c) in patients with type 2 diabetes and coronary artery disease	2017	not elderly patients
187	Carrasquillo	Effect of a Community Health Worker Intervention Among Latinos With Poorly Controlled Type 2 Diabetes: The Miami Healthy Heart Initiative Randomized Clinical Trial	2017	not elderly patients
188	Dasgupta	Physician step prescription and monitoring to improve ARTERial health (SMARTER): A randomized controlled trial in patients with type 2 diabetes and hypertension	2017	not elderly patients
189	Do valle Nascimento	A pilot study of a Community Health Agent-led type 2 diabetes self-management program using Motivational Interviewing-based approaches in a public primary care center in São Paulo, Brazil	2017	not elderly patients
190	dos anjos	Effects of aerobic exercise on functional capacity, anthropometric measurements and inflammatory markers in diabetic elderly women	2017	without control group
191	Espeland	Effects of Physical Activity Intervention on Physical and Cognitive Function in Sedentary Adults With and Without Diabetes	2017	not elderly patients
192	Francois	Combined Interval Training and Post-exercise Nutrition in Type 2 Diabetes: A Randomized Control Trial	2017	not elderly patients
193	Francois	The impact of acute high-intensity interval exercise on biomarkers of cardiovascular health in type 2 diabetes	2017	not elderly patients
194	Gallagher	Changes in skeletal muscle and organ size after a weight-loss intervention in overweight and obese type 2 diabetic patients	2017	not elderly patients
195	Galle	Improving Self-Management of Type 2 Diabetes in Overweight and Inactive Patients Through an Educational and Motivational Intervention Addressing Diet and Physical Activity: A Prospective Study in Naples, South Italy	2017	not elderly patients

196	Jiang	The effect of care intervention for obese patients with type II diabetes	2017	not elderly patients
197	Karimi	Effects of Supervised Structured Aerobic Exercise Training Program on Interleukin-6, Nitric Oxide Synthase-1, and Cyclooxygenase-2 in Type 2 Diabetes Mellitus	2017	not elderly patients
198	Kaur	Optimization of aerobic exercise protocols in diabetes mellitus: A randomized trial	2017	not elderly patients
199	Liu	Effect of square aerobic exercise on cardiovascular risk factors and health-related quality of life in Chinese women with type 2 diabetes	2017	not elderly patients
200	Mallard	Exercise intensity, redox homeostasis and inflammation in type 2 diabetes mellitus	2017	not elderly patients
201	Mazzuca	Supervised vs. self-selected physical activity for individuals with diabetes and obesity: the Lifestyle Gym program	2017	not elderly patients
202	Miele	The effects of chronic aerobic exercise on cardiovascular risk factors in persons with diabetes mellitus	2017	not clinical trial
203	Miyamoto	Non-locomotive physical activity intervention using a tri-axial accelerometer reduces sedentary time in type 2 diabetes	2017	not elderly patients
204	Najafipour	Effect of regular exercise training on changes in HbA1c, BMI and VO(2)max among patients with type 2 diabetes mellitus: an 8-year trial	2017	not elderly patients
205	Nygaard	Long-term effects of daily postprandial physical activity on blood glucose: a randomized controlled trial	2017	not elderly patients
206	Pahra	Impact of post-meal and one-time daily exercise in patient with type 2 diabetes mellitus: a randomized crossover study	2017	not elderly patients
207	Pandey	The Impact of Burst Exercise on Cardiometabolic Status of Patients Newly Diagnosed With Type 2 Diabetes	2017	not elderly patients
208	Shakil	Effects of supervised structured aerobic exercise training program on high and low density lipoprotein in patients with type II diabetes mellitus	2017	not elderly patients

209	Shakil	Effects of supervised structured aerobic exercise training program on fasting blood glucose level, plasma insulin level, glycemic control, and insulin resistance in type 2 diabetes mellitus	2017	not elderly patients
210	Stoa	High-intensity aerobic interval training improves aerobic fitness and HbA1c among persons diagnosed with type 2 diabetes	2017	not elderly patients
211	Suntraluck	The Relative Efficacy of Land-Based and Water-Based Exercise Training on Macro- and Microvascular Functions in Older Patients With Type 2 Diabetes	2017	without control group
212	Terada	Cardiometabolic risk factors in type 2 diabetes with high fat and low muscle mass: At baseline and in response to exercise	2017	not elderly patients
213	Rehman	Effects of supervised structured aerobic exercise training programme on level of Exertion, dyspnoea, VO2 max and Body Mass Index in patients with type 2 diabetes mellitus	2017	not elderly patients
214	Vanroy	Short- and long-term effects of a need-supportive physical activity intervention among patients with type 2 diabetes mellitus: A randomized controlled pilot trial	2017	not elderly patients
215	Arovah	Walking with Diabetes (WW-DIAB) programme a walking programme for Indonesian type 2 diabetes mellitus patients: A pilot randomised controlled trial	2018	not elderly patients
216	Zadeh	Diets along with interval training regimes improves inflammatory & anti-inflammatory condition in obesity with type 2 diabetes subjects	2018	not elderly patients
217	Bellavere	Effects of aerobic or resistance exercise training on cardiovascular autonomic function of subjects with type 2 diabetes: A pilot study	2018	not elderly patients
218	Junior	Multicomponent Exercise Improves Hemodynamic Parameters and Mobility, but Not Maximal Walking Speed, Transfer Capacity, and Executive Function of Older Type II Diabetic Patients	2018	not elderly patients

219	Duvivier	Reducing sitting time versus adding exercise: differential effects on biomarkers of endothelial dysfunction and metabolic risk	2018	not elderly patients
220	Faroqi	Evaluating the clinical implementation of structured exercise: A randomized controlled trial among non-insulin dependent type II diabetics	2018	not elderly patients
221	Francois	Cardiovascular benefits of combined interval training and post-exercise nutrition in type 2 diabetes	2018	not elderly patients
222	Gholami	Effect of aerobic training on nerve conduction in men with type 2 diabetes and peripheral neuropathy: A randomized controlled trial	2018	not elderly patients
223	Maillard	High-intensity interval training is more effective than moderate-intensity continuous training in reducing abdominal fat mass in postmenopausal women with type 2 diabetes: A randomized crossover study	2018	not intervention
224	Nomura	Assessment of lower extremity muscle mass, muscle strength, and exercise therapy in elderly patients with diabetes mellitus	2018	not clinical trial
225	Nuhu	Influence of a mini-trampoline rebound exercise program on insulin resistance, lipid profile and central obesity in individuals with type 2 diabetes	2018	not elderly patients
226	Pisabarro	A 20-week exercise program improves markers of cognitive, inflammatory and metabolic status in type 2 diabetic patients	2018	not elderly patients
227	Delevatti	Quality of life and sleep quality are similarly improved after aquatic or dry-land aerobic training in patients with type 2 diabetes: A randomized clinical trial	2018	not elderly patients
228	Ranasinghe	Study protocol: a randomised controlled trial of supervised resistance training versus aerobic training in Sri Lankan adults with type 2 diabetes mellitus: SL-DART study	2018	not clinical trial
229	Saghebjo	The effect of 12 weeks of aerobic training on serum levels high sensitivity C-reactive protein, tumor necrosis factor-alpha, lipid profile and anthropometric characteristics in middle-age women patients with type 2 diabetes	2018	not elderly patients

230	Ur	Response to a Supervised Structured Aerobic Exercise Training Program in Patients with Type 2 Diabetes Mellitus - Does Gender Make a Difference? A Randomized Controlled Clinical Trial	2018	not elderly patients
231	Shellington	Results From a Feasibility Study of Square-Stepping Exercise in Older Adults With Type 2 Diabetes and Self-Reported Cognitive Complaints to Improve Global Cognitive Functioning	2018	no outcome
232	Faria	COST-EFFECTIVE EXERCISE PROGRAMS ON HEALTH-STATUS OF MALAYSIAN DIABETIC INDIVIDUALS - A SOCIO-PSYCHOLOGICAL ANALYSIS	2018	not elderly patients
233	Verma	A dose-response study of aerobic training for oxygen uptake, oxidative stress and cardiac autonomic function in type 2 diabetes mellitus: study protocol for a randomized controlled trial	2018	not elderly patients
234	Winding	The effect on glycaemic control of low-volume high-intensity interval training versus endurance training in individuals with type 2 diabetes	2018	not elderly patients
235	Wormgoor	Acute blood glucose, cardiovascular and exaggerated responses to HIIT and moderate-intensity continuous training in men with type 2 diabetes mellitus	2018	not elderly patients
236	Ahmed	Effect of high intensity interval training on heart rate variability and aerobic capacity in obese adults with type 2 Diabetes Mellitus	2019	not elderly patients
237	Ahmed	Efficacy of high intensity interval training on endothelial function in diabetics with peripheral arterial insufficiency	2019	not available
238	Dominguez	Effect of a multifactorial intervention on the increase in physical activity in subjects with type 2 diabetes mellitus: a randomized clinical trial (EMID Study)	2019	not elderly patients
239	Dominguez	Acute effect of healthy walking on arterial stiffness in patients with type 2 diabetes and differences by age and sex: a pre-post intervention study	2019	not elderly patients

240	Bastien	Effect of PPAR γ agonist on aerobic exercise capacity in relation to body fat distribution in men with type 2 diabetes mellitus and coronary artery disease: a 1-yr randomized study	2019	not elderly patients
241	Berger	Change in Cardiometabolic Risk Factors Associated With Magnitude of Weight Regain 3 Years After a 1-Year Intensive Lifestyle Intervention in Type 2 Diabetes Mellitus: The Look AHEAD Trial	2019	not elderly patients
242	Blankenship	Managing free-living hyperglycemia with exercise or interrupted sitting in type 2 diabetes	2019	not elderly patients
243	Bock	Reduction in HbA1c with Exercise videogames among participants with elevated HbA1c: Secondary analysis of the Wii Heart Fitness trial	2019	not elderly patients
244	Bourne	Electrically assisted cycling for individuals with type 2 diabetes mellitus: protocol for a pilot randomized controlled trial	2019	not clinical trial
245	Das	Low-energy diet and physical activity for the remission of type 2 diabetes: a paradigm shift	2019	not clinical trial
246	Davis	An Intensive Lifestyle Intervention to Treat Type 2 Diabetes in the Republic of the Marshall Islands: Protocol for a Randomized Controlled Trial	2019	not clinical trial
247	de Sousa	Biomarkers of insulin action during single soccer sessions before and after a 12-week training period in type 2 diabetes patients on a caloric-restricted diet	2019	not elderly patients
248	Elrefaey	Acute aerobic exercise induced irisin release in type 2 diabetic patients: Randomized clinical trial	2019	not elderly patients
249	Faroqi	STRONG-D: Strength training regimen for normal weight diabetics: Rationale and design	2019	not clinical trial
250	Fatimathu	Lifestyle practices and glycemic control among type 2 diabetic patients in north kerala	2019	not elderly patients
251	Gulsin	Rationale, design and study protocol of the randomised controlled trial: Diabetes Interventional Assessment of Slimming	2019	not clinical trial

		or Training to Lessen Inconspicuous Cardiovascular Dysfunction (the DIASTOLIC study)		
252	Hale	Protocol for a randomised controlled trial to evaluate the effectiveness of the diabetes community exercise and education programme (DCEP) for long-term management of diabetes	2019	not clinical trial
253	Ildarabadi	Effects of face-to-face and online training on self-care of middle-aged and elderly people with type 2 diabetes: A comparative study	2019	not elderly patients
254	Kitic	Study protocol for a multicentre, controlled non-randomised trial: benefits of exercise physiology services for type 2 diabetes (BEST)	2019	not clinical trial
255	Krankel	Exercise training to reduce cardiovascular risk in patients with metabolic syndrome and type 2 diabetes mellitus: How does it work?	2019	not clinical trial
256	Lucertini	Discontinuously supervised aerobic training vs. physical activity promotion in the self-management of type 2 diabetes in older Italian patients: design and methods of the 'TRIPL-A' randomized controlled trial	2019	not clinical trial
257	Magalhaes	Effects of combined training with different intensities on vascular health in patients with type 2 diabetes: a 1-year randomized controlled trial	2019	not elderly patients
258	Mendes	High-Intensity Interval Training Versus Moderate-Intensity Continuous Training in Middle-Aged and Older Patients with Type 2 Diabetes: A Randomized Controlled Crossover Trial of the Acute Effects of Treadmill Walking on Glycemic Control	2019	not elderly patients
259	Mey	Skeletal muscle Nur77 and NOR1 insulin responsiveness is blunted in obesity and type 2 diabetes but improved after exercise training	2019	not elderly patients
260	Motkova	MULTIDISCIPLINARY LIFESTYLE MANAGEMENT APPROACH IN PATIENTS WITH TYPE 2 DIABETES MELLITUS IN REAL CLINICAL	2019	not elderly patients

		PRACTICE. RESULTS OF APPLICATION "LIFE IS EASY" PROGRAMME IN RUSSIA		
261	Olioso	Effects of Aerobic and Resistance Training on Circulating Micro-RNA Expression Profile in Subjects With Type 2 Diabetes	2019	not elderly patients
262	Piche	Benefits of 1-Year Lifestyle Modification Program on Exercise Capacity and Diastolic Function Among Coronary Artery Disease Men With and Without Type 2 Diabetes	2019	not elderly patients
263	Stubbs	Randomized Controlled Trial of Physical Exercise in Diabetic Veterans With Length-Dependent Distal Symmetric Polyneuropathy	2019	not elderly patients
264	Suryanegara	High intensity interval training protects the heart during increased metabolic demand in patients with type 2 diabetes: a randomised controlled trial	2019	not elderly patients
265	Szilagyi	Sports therapy and recreation exercise program in type 2 diabetes: randomized controlled trial, 3-month follow-up	2019	not elderly patients
266	Theresa	The effects of poco-poco dance on the executive functions of type 2 diabetes mellitus patients with mild cognitive impairment achieved through improvements in neuronal functions and plasticity	2019	not elderly patients
267	Viana	Prescribing high-intensity interval exercise by RPE in individuals with type 2 diabetes: metabolic and hemodynamic responses	2019	not elderly patients
268	Wang	Health literacy and exercise-focused interventions on clinical measurements in Chinese diabetes patients: A cluster randomized controlled trial	2019	not elderly patients
269	Wilson	HIIT Improves Left Ventricular Exercise Response in Adults with Type 2 Diabetes	2019	not elderly patients
270	Zaidi	Effects of exercise training on inflammasome-related mediators and their associations to glucometabolic variables in patients with combined coronary artery disease and type 2 diabetes mellitus: Sub-study of a randomized control trial	2019	not elderly patients

271	Zurlo	One-year caloric restriction and 12-week exercise training intervention in obese adults with type 2 diabetes: emphasis on metabolic control and resting metabolic rate	2019	not elderly patients
272	Arefirad	Effects of interval training on cardio metabolic risk factors and nitric oxide in type 2 diabetes patients: a randomized controlled trial	2020	not elderly patients
273	Benham	Significant Dose-Response between Exercise Adherence and Hemoglobin A1c Change	2020	not elderly patients
274	Borhade	Diabetes mellitus and exercise	2020	not clinical trial
275	Cox	Glycemic excursion minimization in the management of type 2 diabetes: a novel intervention tested in a randomized clinical trial	2020	not elderly patients
276	Furlano	Feasibility of a 26-Week Exercise Program to Improve Brain Health in Older Adults at Risk for Type 2 Diabetes: A Pilot Study	2020	not elderly patients
277	Ghardashi	Improved carotid intima-media thickness-induced high-intensity interval training associated with decreased serum levels of Dkk-1 and sclerostin in type 2 diabetes	2020	not elderly patients
278	Gholami	Cycle Training improves vascular function and neuropathic symptoms in patients with type 2 diabetes and peripheral neuropathy: A randomized controlled trial	2020	not elderly patients
279	Gupta	Effectiveness of Yoga-based Exercise Program Compared to Usual Care, in Improving HbA1c in Individuals with Type 2 Diabetes: A Randomized Control Trial	2020	not elderly patients
280	Hegde	Effects of Yoga Versus Sham Yoga on Oxidative Stress, Glycemic Status, and Anthropometry in Type 2 Diabetes Mellitus: A Single-Blinded Randomized Pilot Study	2020	not elderly patients
281	Iwai	Usefulness of Exercise for Home Blood Pressure Control in People with Diabetes: A Study Protocol for a Crossover Randomized Controlled Trial	2020	not clinical trial

282	Kaplan	The Effect of the Transtheoretical Model Based Walking Exercise Training and Follow-Up on Improving Exercise Behavior and Metabolic Control in Patients with Type 2 Diabetes	2020	not elderly patients
283	Leite	Impact of a supervised multicomponent physical exercise program on cognitive functions in patients with type 2 diabetes	2020	no outcome
284	Li	Effects of fitness qigong and tai chi on middle-aged and elderly patients with type 2 diabetes mellitus	2020	not elderly patients
285	Machado	Acute and chronic effects of muscle power training on blood pressure in elderly patients with type 2 diabetes mellitus	2020	without control group
286	ranasinghe	Glycemic and cardiometabolic effects of exercise in South Asian Sri Lankans with type 2 diabetes mellitus: A randomized controlled trial Sri Lanka diabetes aerobic and resistance training study (SL-DARTS)	2020	not elderly patients
287	Seyam	Effect of Walking on Sand with Dietary Intervention in Overweight Type 2 Diabetes Mellitus Patients: A Randomized Controlled Trial	2020	not elderly patients
288	Sorensen	Higher levels of daily physical activity are associated with better skin microvascular function in type 2 diabetes—The Maastricht Study	2020	not elderly patients
289	Verboven	Impact of Exercise-Nutritional State Interactions in Patients with Type 2 Diabetes	2020	without control group
290	Wang	Study on the effect of lifestyle intervention on metabolic indexes of rural patients with type 2 diabetes mellitus	2020	without control group
291	Wasenius	Low-cost exercise interventions improve long-term cardiometabolic health independently of a family history of type 2 diabetes: a randomized parallel group trial	2020	not elderly patients
292	Way	The effect of low-volume high-intensity interval training on cardiovascular health outcomes in type 2 diabetes: A randomised controlled trial	2020	not elderly patients

293	Wei	Health literacy and exercise interventions on clinical outcomes in Chinese patients with diabetes: a propensity score-matched comparison	2020	not elderly patients
294	Whipple	Influence of Changes in Sedentary Time on Outcomes of Supervised Exercise Therapy in Individuals with Comorbid Peripheral Artery Disease and Type 2 Diabetes	2020	not elderly patients
295	Yang	The impact of exercise on serum irisin, osteocalcin, and adiponectin levels and on glycolipid metabolism in patients with type 2 diabetes	2020	not elderly patients
296	Bilak	Cardiovascular and systemic determinants of exercise capacity in people with type 2 diabetes mellitus	2020	not clinical trial
297	Bilger	Process- and Outcome-Based Financial Incentives to Improve Self-Management and Glycemic Control in People with Type 2 Diabetes in Singapore: A Randomized Controlled Trial	2020	not elderly patients
298	MacDonald	One-year intensive lifestyle intervention and improvements in health-related quality of life and mental health in persons with type 2 diabetes: A secondary analysis of the U-TURN randomized controlled trial	2020	not elderly patients

Anexo 3. Características de los estudios incluidos en la revisión sistemática (n=7).

Study	Country	Design	Main inclusion criteria	Main exclusion criteria	Analyzed sample size (I/C)	Exercise intervention	Time of intervention (h/w; follow up)	Comparator	Adverse effect	Primary outcome	Conclusion
Madden, 2010 ²⁶	Canada	Randomized single-blind study	Older than 65 years, T2D for at least 5 years, normal ECG, normal treadmill maximal exercise stress test	History of angina, myocardial infarction, stroke, chronic pulmonary disease	19/20	Treadmill and cycle ergometer	3h/w; 12 weeks	Nonstrenuous core (exercise ball), nonstrenuous strength training (very light dumbbells)	No reported	Change in Baroreflex function	Aerobic exercise can reverse function impairments of the arterial baroreflex function
Sung, 2012 ³⁰	Korea	Randomized open-label study	Older than 65 years with T2D, scored more than 24 points on the Mini-Mental State Examination	Participants with habitual alcohol consumption or liver disease	22/18	Walking exercise	2.5h/w; 24 weeks.	Standard medical care	No reported	Diet control and the management of complications	Aerobic exercise increases daily activity and glucose metabolism
Madden, 2013 ²⁷	Canada	Randomized single-blind study	Older than 65 years with T2D for at least 5 years, normal ECG, sedentary at the beginning of the study	History of angina, myocardial infarction, stroke, chronic pulmonary disease, smoking in the last 5 years	20/20	Treadmill, cycle ergometer	3h/w; 12 weeks	exercise ball, nonstrenuous strength training	Intervention: Syncopal response with carotid sinus massage: 1 (5%)	Attenuation of the vasodepressive response	Vasodepressive carotid sinus hypersensitivity is resistant to aerobic exercise
Parra-Sánchez, 2015 ³³	Spain	Randomized single-blind study	Aged between 65-80 years, T2D	Incapacity to recognize, not being sedentary, history of retinopathy, advanced nephropathy, congestive heart failure	47/41	Walking	2h/w; 12 weeks	No exercise	Intervention: stroke: 1 (2%), sprain: 1 (2%) Control: stroke: 1 (2%)	Change in glycated hemoglobin	Aerobic exercise is associated with an improvement in glycosylated hemoglobin
Askari, 2018 ²⁸	Iran	Randomized Open label study	Older than 60 years, T2D for at least 1 year, lack of cognitive and movement disabilities.	Absence of >2 sessions in the training program	54/54	Walking and jogging	1 h/w, 12 weeks	Without detail	No reported	Change in metabolic indices	Aerobic exercise improves metabolic indices
Sijie Tan, 2018 ²⁹	China	Randomized open-label study	Women with T2D between 6-10 years, aged between 60-69 years	Inability to participate in exercise, history of heart disease, blood pressure greater than 160/95 mmhg, pulmonary diseases,	16/15	Walking or running	3 h/w; 12 weeks	Habitual physical activity levels	No reported	Change in body composition, blood glucose, lipid profile, serum adipokine and insulin resistance	Aerobic exercise improve in body composition, blood glucose and insulin resistance
Hagag, 2020 ³⁴	Egypt	Randomized open-label study	Aged between 60-70 years, BMI ranged between 25-34.9, T2D between 2-7 years	History of dyslipidemia, hypertension, complications of T2D	20/20	Treadmill	2.25h/w; 12 weeks	Standard medical care	No reported	Change in antioxidant defense and cardio-metabolic risk factors	Aerobic exercise is effective on cardiometabolic risks, oxidative stress markers and antioxidant status

I: intervention, C: comparator, h: hours, w: week, T2D: type 2 diabetes, ECG: echocardiography

Anexo 4. Riesgo de sesgo de los ECA incluidos según la herramienta Cochrane de riesgo de sesgo.

Study	Randomization process	Deviations from intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall
Madden (2010)	!	+	+	+	+	!
Sung (2012)	-	!	+	+	+	-
Madden (2013)	+	+	+	+	+	+
Parra-Sanchez (2015)	!	!	+	+	+	!
Askari (2018)	!	!	+	+	+	!
Sijie (2018)	!	!	+	+	+	!
Hagag (2020)	!	!	+	+	+	!

ECA: ensayos controlados aleatorios

Anexo 5. análisis de sensibilidad

Subgroup	Overall results SMD (95%CI)	Excluded study	Results after exclusion of each study SMD (95% CI)
Fasting glucose	-1.76 [-2.78; -0.74]	Madden(2010)	-1.47 [-2.39; -0.47]
		Sung(2012)	-1.96 [-3.33; -0.58]
		Madden(2013)	-1.49 [-2.51; -0.47]
		Askari(2018)	-2.11 [-3.09; -1.13]
		Sijie(2018)	-1.82 [-3.09; -0.55]
Triglycerides	-0.34 [-0.67; -0.01]	Sung(2012)	-0.25 [-0.57; 0.08]
		Parra - Sanchez(2015)	-0.44 [-0.71; -0.17]
		Askari(2018)	-0.40 [-0.87; 0.07]
		Sijie(2018)	-0.26 [-0.59; 0.07]
		Hagag(2020)	-0.36 [-0.76; 0.05]
HDL	0.41 [0.11; 0.72]	Sung(2012)	0.39 [0.02; 0.77]
		Parra - Sanchez(2015)	0.59 [0.32; 0.86]
		Askari(2018)	0.24 [-0.03; 0.51]
		Sijie(2018)	0.44 [0.07; 0.80]
		Hagag(2020)	0.41 [0.03; 0.79]
SBP	-1.67 [-2.74; -0.61]	Madden(2010)	-1.41 [-2.55; -0.26]
		Madden(2013)	-1.32 [-2.35; -0.29]
		Parra - Sanchez(2015)	-2.08 [-3.19; -0.97]
		Hagag(2020)	-1.91 [-3.49; -0.33]
DBP	-1.47 [-2.34; -0.60]	Madden(2010)	-1.50 [-2.68; -0.31]
		Madden(2013)	-1.00 [-1.52; -0.48]
		Parra - Sanchez(2015)	-1.80 [-2.79; -0.80]
		Hagag(2020)	-1.62 [-2.87; -0.37]
Glycated haemoglobin	-0.63 [-0.87; -0.39]		

Sung(2012)	-0.60 [-0.88; -0.32]
Parra - Sanchez(2015)	-0.78 [-1.08; -0.48]
Askari(2018)	-0.60 [-0.95; -0.26]
Hagag(2020)	-0.60 [-0.87; -0.32]

SMD: standardized mean difference CI: confidence interval

HDL: high density lipoprotein

SBP: systolic blood pressure

DBP: diastolic blood pressure

Anexo 6. Análisis de subgrupos

Subgroup	n	Test of relationship		Test of heterogeneity	
		SMD (95% CI)	P value	I ²	P-value
Fasting glucose					
Intensity of exercise					
High or vigorous	2	-2.05 [-4.05; -0.06]	0.04	92%	<0.01
Low or moderate	1	-1.57 [-2.39; -0.75]	<0.01		
No reported	2	-1.62 [-3.96; 0.72]	0.17	96%	<0.01
Supervision of exercise					
Yes	3	-2.48 [-3.44; -1.53]	<0.01	71%	0.03
No	2	-0.70 [-1.27; -0.12]	0.02	57%	0.13
Total Duration in hours					
>30	4	-2.11 [-3.09; -1.13]	<0.01	82%	<0.01
<30	1	-0.46 [-0.85; -0.08]	0.02		
Triglycerides					
Intensity of exercise					
High or vigorous	1	-0.78 [-1.43; -0.13]	0.02		
Low or moderate	2	-0.54 [-1.02; -0.07]	0.03	0%	0.37
No reported	2	-0.09 [-0.44; 0.26]	0.60	39%	0.20
Supervision of exercise					
Yes	3	-0.28 [-0.80; 0.23]	0.28	59%	0.09
No	2	-0.45 [-0.94; 0.03]	0.07	44%	0.18
Total Duration in hours					
>30	2	-0.79 [-1.28; -0.30]	<0.01	0%	0.96
<30	3	-0.14 [-0.40; 0.13]	0.31	9%	0.33

HDL						
Intensity of exercise						
High or vigorous	1	0.52 [-0.12; 1.15]	0.11			
Low or moderate	2	0.37 [-0.10; 0.84]	0.13	0%		0.71
No reported	2	0.41 [-0.29; 1.12]	0.25	85%		0.01
Supervision of exercise						
Yes	3	0.18 [-0.12; 0.48]	0.24	0%		0.56
No	2	0.70 [0.37; 1.03]	<0.01	0%		0.5
Total Duration in hours						
>30	2	0.40 [-0.07; 0.88]	0.09	0%		0.60
<30	3	0.42 [-0.06; 0.90]	0.08	69%		0.04
Systolic blood pressure						
Intensity of exercise						
High or vigorous	1	-2.50 [-3.34; -1.65]	<0.01			
Low or moderate	1	-1.06 [-1.73; -0.39]	<0.01			
No reported	2	-1.63 [-3.79; 0.53]	0.14	95%		<0.01
Supervision of exercise						
Yes	4	-1.67 [-2.24; -0.61]	<0.01	90%		<0.01
No	0		--			
Total Duration in hours						
>30	2	-2.48 [-3.24; -2.01]	<0.01	0%		0.66
≤30	2	-0.74 [-1.20; -0.27]	<0.01	36%		0.21
Dystolic Blood pressure						
Intensity of exercise						
High or vigorous	1	-1.47 [-2.18; -0.76]	<0.01			
No reported	2	-1.74 [-4.01; 0.53]	0.13	95%		<0.01
Low or moderate	1	-1.11 [-1.78; -0.44]	<0.01			
Supervision of exercise						
Yes	4	-1.47 [-2.34; -0.60]	<0.01	86%		<0.01
No	0					
Total Duration in hours						
>30	2	-2.17 [-3.61; -0.74]	<0.01	84%		0.01
<30	2	-0.79 [-1.25; -0.33]	<0.01	34%		0.22
Glycated haemoglobin						
Intensity of exercise						

High or vigorous	1	-0.85 [-1.50; -0.20]	0.01		
Low or moderate	1	-0.86 [-1.52; -0.21]	<0.01		
No reported	2	-0.55 [-0.89; -0.20]	<0.01	35%	0.22
Supervision of exercise					
Yes	2	-0.55 [-1.01; -0.08]	0.02	38%	0.20
No	2	-0.76 [-1.09; -0.42]	<0.01	0%	0.74
Total Duration in hours					
>30	1	-0.85 [-1.50; -0.20]	0.01		
<30	3	-0.60 [-0.88; -0.32]	<0.01	13%	0.32

n: number of studies, SMD: standardized mean difference CI: confidence interval

1. The Intensity of exercise was defined
2. The study was considered supervised if

Anexo 7. Lista de verificación de PRISMA

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 5

Section and Topic	Item #	Checklist item	Location where item is reported
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary Material 1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7

Section and Topic	Item #	Checklist item	Location where item is reported
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Pages 7 - 8
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 7
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 8
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 8
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Pages 7 - 8
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Page 8
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 8
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 8
RESULTS			

Section and Topic	Item #	Checklist item	Location where item is reported
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary Material 2
Study characteristics	17	Cite each included study and present its characteristics.	Supplementary Material 3
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Supplementary Material 4
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Figure 2 - 4
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 9
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Pages 9 - 11
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Pages 9 - 11
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Supplementary Material 4
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Supplementary Material 4

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Table 1
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pages 11 - 14
	23b	Discuss any limitations of the evidence included in the review.	Page 15
	23c	Discuss any limitations of the review processes used.	Page 15
	23d	Discuss implications of the results for practice, policy, and future research.	Page 15
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Page 5
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 16
Competing interests	26	Declare any competing interests of review authors.	Page 16
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Supplementary material 3

Anexo 8. Aprobación de Ética

COMITÉ INSTITUCIONAL DE ÉTICA EN INVESTIGACIÓN



CONSTANCIA N° 71-CIEI-CIENTÍFICA-2021

El presidente del Comité Institucional de Ética en Investigación de la Universidad Científica del Sur (CIEI-CIENTÍFICA) da constancia que el proyecto de investigación, cuyos datos se registran a continuación, ha sido aprobado por el CIEI-CIENTÍFICA.

Código de registro: **105-2021-PRE15**

Título: **Efectos del ejercicio aeróbico sobre los componentes del síndrome metabólico en adultos mayores con diabetes mellitus tipo 2: Revisión sistemática**

Investigador(a): **Mercedes Miranda Tueros
Joshua Jimmy Rony Ramírez Peña**

La aprobación del proyecto de investigación implica que el documento presentado a evaluación cumple con los lineamientos de Universidad en materia de investigación y ética, los cuales se sustentan en la normativa internacional vigente. Adicionalmente, en el contexto de la pandemia de enfermedad por COVID-19, le recomendamos cumplir con las normas publicadas por el estado peruano (accesos, medidas de bioseguridad, etc.) y tener los permisos de las instituciones en las que realizará el estudio antes de ejecutarlo.

En tal sentido, esta aprobación carecerá de valor si es que el proyecto de investigación arriba indicado es modificado de cualquier forma. Toda enmienda, añadido, eliminación o eventualidad (eventos adversos, etc.) posterior a la fecha de aprobación debe ser reportado al CIEI-CIENTÍFICA.

La vigencia de la aprobación de este documento es de dieciocho (18) meses (hasta el 27 de agosto del 2022), periodo en el que puede desarrollarse el proyecto. Cualquier trámite para su renovación deberá ser enviado antes del término de la vigencia de este documento, debiendo suspenderse todo desarrollo hasta que la renovación sea aprobada. La presente aprobación será ratificada en la sesión del CIEI más próxima.

Villa El Salvador, 28 de febrero de 2021




Mg. Fulton Paul Rivera Albinagorta
Presidente
Comité Institucional de Ética en Investigación

Anexo 9. Resolución directoral académica de carrera de aprobación del proyecto



RESOLUCIÓN DIRECTORAL ACADÉMICA DE CARRERA No. 150 - DACMH-DAFCS-U. CIENTIFICA-2021

Lima, 01 de marzo del 2021

VISTO:

El informe de revisión independiente académica y la aprobación de un Comité de Ética del proyecto de tesis titulado: **“EFECTOS DEL EJERCICIO AERÓBICO SOBRE LOS COMPONENTES DEL SÍNDROME METABÓLICO EN ADULTOS MAYORES CON DIABETES MELLITUS TIPO 2: REVISIÓN SISTEMÁTICA”**.

CONSIDERANDO:

Que, de acuerdo al Reglamento General de la Universidad Científica del Sur y el reglamento y Procedimientos de trabajos de Investigación para obtener el **Título Profesional de Médico Cirujano**.

Que, de acuerdo a la normativa vigente de la Universidad Científica del Sur, en uso de las atribuciones conferidas al Director Académico de la Carrera.

SE RESUELVE:

ART. 1° Aprobar, en vías de regularización e inscribir el proyecto de tesis titulado: **“EFECTOS DEL EJERCICIO AERÓBICO SOBRE LOS COMPONENTES DEL SÍNDROME METABÓLICO EN ADULTOS MAYORES CON DIABETES MELLITUS TIPO 2: REVISIÓN SISTEMÁTICA”**, presentado por los alumnos **MERCEDES MIRANDA TUEROS y JOSHUA JIMMY RONY RAMIREZ PEÑA** con N° de registro: **105-2021-PRE15**.

ART. 2° Nombrar a la Docente Isabel Angelica Pinedo Torres, como asesor para el desarrollo de la tesis en cuestión.

Regístrese, comuníquese y archívese.



Mg. JORDI GRAU MONGE
Director Académico
Carrera de Medicina Humana



c.c. Archivo