UNIVERSIDAD COMPLUTENSE DE MADRID

FACULTAD DE MEDICINA

TESIS DOCTORAL

Tendencias en el Uso de Servicios Sanitarios y en la Prevalencia de Estilos de Vida en la Población con Diabetes en España

MEMORIA PARA OPTAR AL GRADO DE DOCTORA

PRESENTADA POR

Luyi Zeng Zhang

DIRIGIDA POR

Javier de Miguel Díez
María Natividad Cuadrado Corrales

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DOCTORADO EN INVESTIGACIÓN EN CIENCIAS MÉDICO-QUIRÚRGICAS

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A quienes amo, a quienes me aman
y a quienes me enseñaron el arte de la medicina.

“Mejor es adquirir sabiduría que oro preciado;
y adquirir inteligencia vale más que la plata.”
Proverbios 16:16

“得智慧胜似得金子；
选聪明强如选银子。”
箴言 16:16

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ÍNDICE

1. RESUMEN

Introducción

La Diabetes Mellitus (DM) constituye una enfermedad crónica de elevada prevalencia y con un creciente impacto sanitario a nivel mundial. En las últimas décadas, su incidencia ha experimentado un incremento sostenido, según datos de 11ª edición de *Diabetes Atlas* de la Federación Internacional de Diabetes (IDF), en 2024 se estimaron 589 millones de personas entre 20 y 79 años con DM, y se prevé que esta cifra aumente hasta 853 millones en 2050.

La DM constituye una de las principales causas de morbimortalidad en el mundo, debido a las complicaciones crónicas macrovasculares y microvasculares que conlleva, entre ellas la enfermedad cardiovascular aterosclerótica, la nefropatía, la retinopatía y la neuropatía diabética.

Desde el punto de vista económico, la DM genera una carga sustancial sobre los sistemas de saludo, tanto por los gastos directos derivados de hospitalizaciones, consultas y tratamientos farmacológicos, como por los costes indirectos asociados a la pérdida de productividad y a las muertes prematuras. En 2024, el gasto médico directo atribuible a la DM alcanzó los 1,015 billones de dólares a nivel mundial.

Además, la DM se asocia a un mayor riesgo de desarrollar determinados tipos de cáncer, en particulares los cánceres colorrectales y ginecológicos, a la vez se ha observado una menor participación de las personas con DM en los programas de cribado oncológico poblacional.

Por otro lado, los estilos de vida desempeñan un papel determinante tanto en la aparición como en la evolución de la enfermedad. La adherencia a patrones dietéticos saludables y a actividad física se asocian a un mejor control glucémico y a un menor riesgo de complicaciones.

En este contexto, la DM representa un importante reto de saludo pública por su alta prevalencia, su complejidad clínica y su impacto económico. Esta Tesis Doctoral se estructura para investigar los cribados de cáncer ginecológicos y colorrectal en la población con DM en España, los estilos de vida en las personas con DM y la utilización de recursos sanitarios asociados a la enfermedad.

Objetivos

Analizar la tendencia temporal de adherencia a los cribados de cánceres ginecológicos y colorrectal en la población con DM entre 2014 y 2020; comparar el grado de adherencia a los cribados de cánceres ginecológicos y colorrectales entre la población con y sin DM; identificar los factores predictores de adherencia a los cribados de cáncer ginecológico y colorrectal en la población con DM.

Describir y comparar los hábitos dietéticos y nivel de actividad física entre los individuos con y sin DM; identificar los factores predictores de mayor adherencia a las recomendaciones dietéticas en la población con DM.

Analizar la evolución de hospitalización y visitas a urgencias en las personas con DM de 2014 a 2020; comparar la utilización de recursos sanitarios entre la población con y sin DM, considerando variables sociodemográficas, de estilos de vida y comorbilidades; identificar los factores predictores de mayor consumo de recursos sanitarios en la población con DM.

Material y métodos

Esta Tesis Doctoral se compone de 3 artículos originales, basados en datos procedentes de la *European Heath Interview Survey for Spain* (EHISS), en sus ediciones 2014 y 2020. Se trata de una encuesta realizada por Instituto Nacional de Estadística (INE), dirigida a la población española de 18 años o más. La mayoría de las entrevistas se llevaron a cabo

de manera presencial, sin embargo, a partir de marzo de 2020, debido a la pandemia por COVID-19, una parte de las encuestas se realizó por vía telefónica.

Se clasificaron como personas con DM aquellas que respondieron afirmativamente a la pregunta: "¿Le ha dicho un médico que tiene diabetes?". Cada caso de DM se emparejó con un individuo sin DM del mismo sexo, edad, edición de encuesta y lugar de residencia. En primer artículo, las variables dependientes fueron la realización de mamografía, citología y prueba de sangre oculta en heces, en los dos, tres y dos años previos, respectivamente. En el segundo artículo, estas variables fueron la adherencia al patrón dietético mediterráneo y a la actividad física. En el tercer artículo, estas variables fueron la visita a urgencia y la hospitalización en los últimos 12 meses. Además, se analizaron las influencias de las variables independiente sociodemográficas, de estilo de vida y comorbilidades sobre las variables dependientes.

Resultados

Artículo 1: Se incluyeron un total de 1852 participantes con DM y 1852 controles sin DM. Se observó una mayor adherencia a la mamografía en las mujeres sin DM en comparación con aquellas con DM, aunque no se alcanzó significación estadística (72,9% frente a 68,6%; p = 0,068). De manera similar, se observó una mayor adherencia a la citología cervical (Papanicolaou) en la población sin DM en el grupo de edad entre 60 y 69 años, en comparación con la población con DM (54,0% frente a 45,8%; p = 0,016). La adherencia a la citología cervical entre las mujeres con DM fue significativamente mayor en la EHISS de 2020 (52,0% en 2014 frente a 61,0% en 2020; p = 0,010), al igual que en el caso de la prueba de sangre oculta en heces (13,8% en 2014 frente a 33,8% en 2020; p < 0,001), pero no fue significativa para la mamografía (70,4% en 2014 frente a

66,8% en 2020; p = 0,301). En general, los predictores de adherencia a las pruebas de cribado fueron la mayor edad, el antecedente de cáncer y un nivel educativo más alto.

Artículo 2: Se analizaron un total de 2053 participantes emparejados. Los participantes con DM mostraron una adherencia significativamente mayor a las recomendaciones nutricionales que aquellos sin DM (6,19 frente a 5,30; p < 0,001). Sin embargo, el 88,6% de los individuos con DM reportaron niveles de actividad física sedentarios o bajos. Entre las personas con DM, las mujeres mostraron una mejor adherencia a las recomendaciones nutricionales, mientras que los hombres reportaron niveles más altos de actividad física.

La actividad física moderada o alta se asoció con una mayor adherencia a las recomendaciones nutricionales (OR 1,991; IC del 95%: 1,201-3,146). La mayor edad también se asoció positivamente con la adherencia.

Artículo 3: Se incluyeron 7.854 participantes (3.927 casos y 3.927 controles). La comparación entre los años 2014 y 2020 mostró un descenso en las hospitalizaciones (19,0% vs. 16,1%; p = 0,018) y en las visitas a urgencias (36,2% vs. 28,7%; p < 0,001) entre las personas con DM. Estas presentaron tasas más altas de hospitalización (17,5% vs. 11,1%; p < 0,001) y de visitas a urgencias (32,3% vs. 24,6%; p < 0,001) en comparación con las personas sin DM. Los factores predictores comunes de hospitalización y de visitas a urgencias fueron la percepción negativa del estado de salud y la cardiopatía isquémica.

Conclusiones

En general, hay una menor participación a mamografía y citología en la población con DM frente a aquellos sin DM. Sin embargo, se observó una tendencia a una mayor adherencia al cribado de cáncer cervical y colorrectal en la población con DM entre 2014 a 2020. La mayor edad, el nivel educativo más alto y los antecedentes de cáncer se

asociaron a un mayor nivel de adherencia a los cribados oncológicos en la población con DM.

En cuanto al estilo de vida, existe una mayor adherencia a la dieta mediterránea entre la población con DM frente a aquellas sin DM; no obstante, la población con DM presentaba una mayor tasa de sedentarismo. Las mujeres, la edad avanzada y una actividad física moderada-alta se asociaron a una mayor adherencia dietética. El sexo masculino se asoció a mayor nivel de actividad física.

Finalmente, se observó un descenso significativo de las visitas a urgencia y hospitalizaciones en la población con DM entre 2014 y 2020, aunque sigue siendo un porcentaje marcadamente superior a la población sin DM. Los factores asociados a un mayor uso de recursos sanitarios fueron la percepción negativa del estado de salud y las comorbilidades como cardiopatía isquémica.

2. ABSTRACT

Introduction

Diabetes Mellitus (DM) is a highly prevalent chronic disease with an increasing impact on global healthcare systems. Over recent decades, its incidence has risen steadily. According to the 11th edition of the International Diabetes Federation (IDF) Diabetes Atlas, an estimated 589 million adults aged 20 to 79 were living with DM in 2024, and this figure is projected to reach 853 million by 2050.

DM is one of the leading causes of morbidity and mortality worldwide, due to its chronic macrovascular and microvascular complications including atherosclerotic cardiovascular disease, nephropathy, retinopathy, and diabetic neuropathy.

From an economic perspective, DM imposes a substantial burden on healthcare systems, driven both by direct costs (hospital admissions, medical consultations, pharmacological treatment) and by indirect costs related to productivity loss and premature mortality. In 2024, the global direct medical expenditure attributable to DM reached 1.015 trillion US dollars.

Furthermore, DM is associated with a higher risk of developing certain types of cancer, particularly colorectal and gynecological cancers, while lower participation in population-based cancer screening programs has been observed among individuals with DM.

Lifestyle factors play a decisive role in both the onset and progression of the disease. Adherence to healthy dietary patterns and regular physical activity is associated with improved glycemic control and a reduced risk of complications.

In this context, DM represents a major public health challenge due to its high prevalence, clinical complexity, and economic impact. This Doctoral Thesis is structured to investigate gynecological and colorectal cancer screening in the population with DM in

Spain, lifestyle behaviors among individuals with DM, and the healthcare resource utilization associated with the disease.

Objectives

To analyze the temporal trend in adherence to gynecological and colorectal cancer screening among individuals with DM between 2014 and 2020; to compare the level of adherence to gynecological and colorectal cancer screening between individuals with and without DM; and to identify the predictors of adherence to gynecological and colorectal cancer screening in the population with DM.

To describe and compare dietary habits and physical activity levels between individuals with and without DM; and to identify the predictors of greater adherence to dietary recommendations in the population with DM.

To analyze the evolution of hospitalizations and emergency department visits among individuals with DM from 2014 to 2020; to compare healthcare resource utilization between individuals with and without DM, considering sociodemographic, lifestyle, and comorbidity factors; and to identify the predictors of higher healthcare resource utilization in the population with DM.

Methods and Materials

This Doctoral Thesis consists of three original articles based on data from the European Health Interview Survey for Spain (EHISS), editions 2014 and 2020. This survey is conducted by the National Institute of Statistics (INE) and targets the Spanish population aged 18 years or older. Most interviews were conducted face-to-face; however, from March 2020 onwards, due to the COVID-19 pandemic, part of the survey was carried out by telephone.

Individuals were classified as having DM if they responded affirmatively to the question: "Has a doctor told you that you have diabetes?". Each individual with DM was matched with a non-DM individual of the same sex, age, survey edition and place of residence. In the first article, the dependent variables were mammography, cervical cytology, and fecal occult blood testing within the previous two, three, and two years, respectively. In the second article, the dependent variables were adherence to the Mediterranean dietary pattern and to physical activity. In the third article, the dependent variables were emergency department visits and hospitalizations within the past 12 months. Additionally, the influence of sociodemographic, lifestyle, and comorbidity independent variables on the dependent variables was analyzed.

Results

Article 1: A total of 1852 participants with reported DM and 1852 controls without DM. A higher adherence to mammography was observed in women without DM compared to those with DM, although statistical significance was not reached (72.9% vs. 68.6%, p = 0.068). Similarly, higher Pap smear adherence was observed in the population without DM in the age group between 60 and 69 years compared to the population with DM (54.0% vs. 45.8%, p = 0.016). Pap smear adherence among women with DM was significantly higher in the EHISS of 2020 (52.0% in 2014 vs. 61.0% in 2020, p = 0.010), as was the case for fecal occult blood testing (13.8% in 2014 vs. 33.8% in 2020, p < 0.001), but it was not significant for mammography (70.4% in 2014 vs. 66.8% in 2020, p = 0.301). Overall, the predictors of adherence to screening tests were older age, history of cancer and higher education level.

Article 2: A total of 2053 matched pairs were analyzed. The participants with DM adhered to significantly more nutritional recommendations than those without DM

(6.19 vs. 5.30; $p < 0.001$). However, 88.6% of the individuals with DM reported sedentary or low PA levels. Among those with DM, women showed better adherence to nutritional recommendations, while men reported higher PA levels. Moderate/high PA was associated with greater adherence to nutritional recommendations (OR 1.991; 95% CI: 1.201-3.146). Older age was also positively associated with adherence.

Article 3: The study included a total of 7854 participants (3927 cases and 3927 controls). A comparison between 2014 and 2020 showed fewer hospitalizations (19.0% vs 16.1%, $p = 0.018$) and emergency department visits (36.2% vs 28.7%, $p < 0.001$) among individuals with DM. Individuals with DM had significantly higher rates of hospitalization (17.5% vs 11.1%; $p < 0.001$) and emergency department visits (32.3% vs 24.6%; $p < 0.001$) vs those without DM. The identified common predictors of hospitalization and emergency department visits were poor self-rated health and cardiac ischemia.

Conclusions

Overall, participation in mammography and cervical cytology screening was lower among individuals with DM than among those without the condition. Nonetheless, from 2014 to 2020, a trend towards improved adherence to cervical and colorectal cancer screening was observed in the DM population. Older age, higher educational attainment, and a prior history of cancer were associated with greater adherence to oncological screening among individuals with DM.

With respect to lifestyle factors, adherence to the Mediterranean diet was higher among participants with DM compared with those without DM; however, higher levels of sedentary behavior were also reported in this group. Female sex, older age, and

moderate-to-high levels of physical activity were associated with greater dietary adherence, whereas male sex was linked to higher physical activity levels.

Finally, emergency department visits and hospital admissions declined significantly among individuals with DM between 2014 and 2020, although these rates remained substantially higher than in the population without DM. Poor self-rated health status and comorbidities, particularly ischemic heart disease, were associated with greater healthcare utilization.

3. ABREVIATURAS Y ACRÓNIMOS

ACA: *American College of Cardiology.*

ADA: *American Diabetes Association.*

AF: Actividad física.

AHA: *American Heart Association.*

CAD: Cetoacidosis diabética.

COVID-19: Enfermedad por coronavirus 2019.

DE: Desviación estándar.

DM: Diabetes mellitus.

DASH: *Dietary Approaches to Stop Hypertension.*

ECVA: Enfermedad cardiovascular aterosclerótica.

EHH: Estado hiperglucémico hiperosmolar.

EHISS: *European Health Interview Survey for Spain.*

EPOC: Enfermedad pulmonar obstructiva crónica.

ERC: Enfermedad renal crónica.

HbA1c: Hemoglobina glicosilada.

HTA: Hipertensión arterial.

IC: Intervalo de confianza.

IDF: *International Diabetes Federation.*

INE: Instituto Nacional de Estadística.

IMC: Índice de masa corporal.

LADA: *Latent Autoinmune Diabetes in Adults*

MODY: *Maturity-Onset Diabetes of the Young.*

OMS: Organización Mundial de la Salud.

OR: Odds Ratio.

RIC: Rango intercuartílico.

SNS: Sistema Nacional de Salud.

4. INTRODUCCIÓN

4.1. Panorama epidemiológico de la diabetes mellitus

4.1.1. Situaciones epidemiológicas de la diabetes

La Diabetes Mellitus (DM) es una enfermedad crónica cuya prevalencia ha ido en aumento a lo largo de los años. Según los datos publicados en la 11ª edición de *Diabetes Atlas* de la Federación Internacional de Diabetes (IDF, en sus siglas en inglés), en 2024 había 589 millones de personas entre 20 y 79 años con DM a nivel mundial, lo que representa el 11,1% de la población global. Se estima que esta cifra aumentará a 853 millones en 2050, lo que supone un incremento del 45% en los próximos 25 años, probablemente relacionado con el envejecimiento poblacional y el avance de la urbanización, especialmente en países de ingresos bajos y medios, donde se espera un mayor crecimiento demográfico[1]. En un estudio de prevalencia basado en datos procedentes de 1.108 estudio poblacionales representativos, se estimó que en 2022 había 828 millones de adultos mayores de 18 años con DM, lo que supone un incremento de 630 millones en comparación con 1990[2].

La región con mayor prevalencia de DM es el Oriente Medio y el Norte de África. Los países con prevalencias más altas ajustadas por edad son Pakistán, Islas Marshall y Kuwait, mientras que en China, India y Estados Unidos se concentra el mayor número de personas con DM en cifras absolutas[1].

En el *Informe mundial global sobre la diabetes* de la Organización Mundial de la Salud (OMS) de 2016, se anunció que la DM fue la causa de 1,5 millones de defunciones en 2012[3]. Esta cifra prácticamente se duplicó según los datos de la IDF en 2024, alcanzando 3,4 millones de muertes atribuibles a la DM, lo que corresponde al 9,3% de la mortalidad global por todas las causas[1].

La edad constituye un importante factor de riesgo para la diabetes: en las personas mayores de 65 años, una de cada cuatro personas presenta DM. La prevalencia es similar entre mujeres y hombres (10,9% vs 11,3%), aunque en términos absolutos hay 9,8 millones más de hombre que de mujeres con la enfermedad. En cuanto a la distribución demográfica, la prevalencia es mayor en áreas urbanas que en zonas rurales (12,7% vs 8,8%)[1].

Por otro lado, existe un elevado porcentaje de casos no diagnosticado. En 2024, 4 de cada 10 personas con DM no estaban diagnosticadas. El porcentaje del infradiagnóstico es mayor en los países con ingresos bajos en comparación con los de ingresos altos (58,7% vs 28,9%), lo que refleja la falta de acceso a los servicios sanitarios y la necesidad de establecer estrategias de detección precoz en los países con ingresos bajos y medios[4], dado que el retraso en el diagnóstico aumenta la tasa de mal control y de complicaciones asociadas[5,6].

A nivel de Europa, la prevalencia de DM fue de 9.8% en 2024, lo que correspondía a 66 millones de personas, y se prevé un incremento del 10% para 2050. La región europea presenta el mayor número de casos de DM tipo 1. Los países con mayor prevalencia de DM son Turquía, la Federación de Rusia, Alemania e Italia, mientras que España ocupa el quinto lugar en cuanto al número de personas con DM[1].

Según la 11ª edición de *Diabetes Atlas* de la IDF, en 2024 se estimaba que en España había 4,7 millones personas con DM, y se prevé que esta cifra aumente a 4,9 millones en 2050[1]. La prevalencia ajustada por edad fue de 9,7%, con un infradiagnóstico de DM estimado del 35,5%[1].

En un estudio realizado en ámbito de Atención Primaria en España, se determinó la prevalencia ajustada por edad de DM tipo1, DM tipo 2 y DM en general de 1,0%, 11,5%

y 12,5%, respectivamente. Además, la prevalencia de DM en la población mayor de 70 años fue el doble, alcanzando el 30,3%[7]. En otro estudio epidemiológicos realizado en España en 2016, la prevalencia de DM fue del 6,66%[8]. Este estudio mostró diferencias significativas entre las comunidades autónomas, con prevalencias más bajas en el norte y centro del país y más alta en el este y sur. La prevalencia más baja se registró en Castilla y León (4,5%) y la más alta en las Islas Canarias (9,7%).

La elevada prevalencia, el infradiagnóstico y las diferencias geográficas de las DM ponen de manifiesto la magnitud del problema y su carácter de emergencia en salud pública, lo que exige diseñar políticas y estrategias específicas orientadas a afrontar de manera eficiente la creciente carga asistencial asociada.

4.1.2. Impacto en la utilización de recursos sanitarios

La DM supone una carga económica importante para la salud pública nacional e internacional. No solo supone gasto médico directo, sino también genera el gasto indirecto derivado de la pérdida de productividad y muertes prematuras[3].

Según los datos de la 11ª edición de *Diabetes Atlas* de la IDF, el gasto médico directo causado de DM ha experimentado un incremento considerable, del 338%, de 2007 a 2024, pasando de 232.000 millones en 2007 a 1.015.000 millones de dólares en 2024[1]. Europa se sitúa en tercer lugar en cuanto a gasto sanitario, representando un 19% del gasto total mundial. No obstante, Europa ocupa el segundo lugar en continente con mayor gasto sanitario relacionado con DM por persona con esta enfermedad (2.950 dólares). Y en España se estima un gasto promedio por persona con DM de 2.808,90 dólares[1].

Estos datos reflejan la creciente presión económica que la DM ejerce sobre los sistemas de salud, lo que pone de manifiesto la necesidad de implementar intervenciones costo-efectivas que permitan optimizar la utilización de recursos sanitarios.

4.2. Bases conceptuales de la diabetes mellitus

4.2.1. Recorrido histórico de la diabetes mellitus

La DM, una enfermedad prevalente, crónica y potencialmente grave, tiene sus orígenes en la historia humana desde hace unos 3.000 años, cuando sus características clínicas fueron descritas por primera vez por un anciano en Egipto[9].

El término "*diabetes*" proviene de una palabra griega "διαβήτης", que significa "atravesar" o "sifón", en referencia a la poliuria. Probablemente fue acuñado por primera vez por Areteo de Capadocia (81-133 d.C). La palabra "*mellitus*", de origen latino, significa "dulce como la miel"[10], fue añadido por el médico británico Thomas Willis en 1675 tras redescubrir la dulzura de la orina y la sangre de los pacientes. Sin embargo, no fue hasta 1776 el otro médico británico, Mattew Dobson, confirmó que dicho dulzor provenía del exceso de azúcar en la orina y en la sangre[10].

En 1889, Joseph von Mering y Oskar Minkowski, en Estrasburgo, consiguieron provocar diabetes a perros mediante la pancreatectomía, aunque el objetivo inicial de la cirugía era estudiar los órganos digestivos. Más adelante, Frederick Banting y Charles Best, intentaron ligar los conductos pancreáticos en perros para provocar la atrofia del páncreas, manteniendo intacto los islotes de Langerhans. A partir de estos islotes, Banting y Best consiguieron extraer y purificar un "extracto pancreático" que, al ser inyectado al perro con diabetes, redujo sus niveles de glucemia. Por este motivo, a Banting le fue concedido el Premio Nobel de Fisiología y Medicina en 1923[11,12].

En 1922, J. B. Collip, refinó el extracto y lo aplicó exitosamente al primer paciente humano, Leonard Thompson, que era un adolescente con diabetes grave. Adicionalmente, con la ayuda de otros laboratorios e industrias farmacéuticos, se logró la producción de insulina a gran escala a finales de 1923[10].

En 1955, Frederick Sanger determinó la secuencia de aminoácidos de la insulina. En 1973, R. S. Yalow, S. A. Berson y sus compañeros detectaron por primera vez la pre-proinsulina, a la que llamaron inicialmente "*big, big insulin*", contribuyendo así a una mejor comprensión de la fisiología de la diabetes. En 1978, la empresa Genentech produjo la primera insulina humana mediante técnica de ADN recombinante en bacterias *E. coli,* ya que previamente se utilizaba insulina animal (porcina/bovina)[10].

Desde entonces, se ha producido un notable avance en el desarrollo de fármacos antidiabéticos e insulinas con diferentes perfiles de acciones, lo que ha aportado nuevas oportunidades terapéuticas a las personas con DM.

4.2.2. Definición actual de la diabetes mellitus

Según el *Informe mundial global sobre la diabetes* de la OMS, la diabetes se define como una enfermedad crónica grave que sobreviene cuando el páncreas no produce suficiente insulina o cuando el organismo no puede utilizar de manera eficaz la insulina que produce[3].

Por otra parte, en los *Standards of Care in Diabetes* edición 2025 de la Asociación Estadounidense de Diabetes (ADA, en sus siglas en inglés), la DM se define como un grupo de trastornos metabólicos de metabolismo de hidratos de carbono en los cuales la glucosa se subutiliza como fuente de energía y se produce en exceso debido a una gluconeogénesis y glucogenólisis inadecuada, lo que resulta en hiperglucemia[13]. Esta es la nueva definición actual, que fue incorporada desde la edición de 2024.

Mientras que la OMS define la DM centrándose en el papel de la insulina, la ADA la enfoca en la alteración de metabolismo de hidratos de carbono. Combinando ambas perspectivas, la DM puede entenderse como un grupo de enfermedades caracterizadas por la alteración de metabolismo de los carbohidratos, ya sea por déficit de insulina, un defecto en su acción, o un desequilibrio entre glucogénesis y glucogenólisis, lo que conduce a un estado de hiperglucemia crónica.

4.2.3. Criterios diagnósticos de la diabetes mellitus

Según los *Standards of Care in Diabetes* de la ADA, edición 2025, se han establecido los siguientes criterios diagnósticos para la DM en personas no gestantes[13]:

- Tener una hemoglobina glicosilada (HbA1c) en sangre igual o mayor a 6,5%. La prueba debe realizarse en un laboratorio utilizando un método validado y certificado.
- Tener una glucosa plasmática en ayuna mayor o igual que 126 mg/dL, tras un ayuno de al menos 8 horas.
- Presentar una glucosa plasmática igual o mayor a 200 mg/dL a las 2 horas de una prueba de sobrecarga oral de 75 g de glucosa.
- En un individuo con síntomas clásicos de hiperglucemia o crisis hiperglucémica, tener glucosa plasmática al azar mayor o igual a 200 mg/dL en cualquier momento del día, independientemente del tiempo transcurrido desde la última ingesta. Los síntomas clásicos son poliuria, polidipsia y pérdida de peso inexplicada.

En ausencia de hiperglucemia inequívoca, el diagnóstico debe confirmarse con una segunda prueba, ya sea mediante dos pruebas el mismo día o la misma prueba medida en dos tiempos. Se incluye en Anexo los criterios diagnósticos de prediabetes.

4.2.4. Clasificación de la diabetes mellitus

Una vez confirmado el diagnóstico de DM, es importante clasificarla correctamente, dado que cada tipo presenta una fisiopatología, una historia natural de la enfermedad y un riesgo de complicaciones diferente. Esto permite individualizar el tratamiento y planificar adecuadamente el seguimiento.

La DM se clasifica en los siguientes tipos:

- DM tipo 1: se debe a la destrucción autoinmune de las células beta pancreáticas, lo que produce un déficit absoluto de insulina[14]. Los principales anticuerpos asociados son: anticuerpo contra células de los islotes, anti-ácido decarboxilasa glutámico, anti-insulina, anti-tirosina fosfatasa (antígeno 2) y anti-transportador de zinc 8[15]. Representa entre el 5 y 10% de los casos de DM. En este grupo se incluyen la denominada *latent autoinmune diabetes in adults* (diabetes tipo LADA) y la diabetes tipo 1 idiopática. Tradicionalmente, la DM tipo 1 suele diagnosticarse en la infancia, con debut característico mediante síntomas cardinales, y aproximadamente en la mitad de los casos, con cetoacidosis diabética[16].
- DM tipo 2: se debe a una pérdida progresiva de la secreción de insulina por células beta pancreáticas, secundaria a la resistencia insulínica en el contexto de síndrome metabólico[17]. Representa el 90-95% de todos los casos de DM. El factor de riesgo más importante para su desarrollo es el sobrepeso y la obesidad, que generan resistencia a la insulina, junto con la edad avanzada y el sedentarismo[18].

Diabetes debida a otras causas[13]:

- Síndrome de diabetes monogénica: son defectos monogénicos que causan disfunción de las células beta pancreáticas. En esta categoría se incluye la diabetes neonatal y la *Maturity-Onset Diabetes of the Young* (diabetes MODY), que

representan menos del 5% de todos los casos de DM. Se debe sospechar en niños o adultos jóvenes que no presentan características típicas de DM tipo 1 y DM tipo 2, pero que tienen antecedentes familiares de DM de varias generaciones consecutivas, en cuyo caso se recomienda realizar un estudio genético.

- Enfermedades pancreáticas exocrinas: pérdida funcional o estructural de la secreción de insulina secundaria a disfunción pancreática exocrina.
- Diabetes inducida por fármacos
- Diabetes asociada a endocrinopatías
- Diabetes gestacional: es la intolerancia a la glucosa de grado variable que aparece por primera vez durante el embarazo, generalmente en el segundo o tercer trimestre. Se excluyen las mujeres con diabetes preexistente (tipo 1 o tipo 2) diagnosticadas antes del embarazo o en el primer trimestre. Se incluye la Tabla 1 en Anexo que recoge los cribados y los criterios diagnósticos de la diabetes gestacional.

4.2.5. Complicaciones crónicas macrovasculares de la diabetes mellitus

La DM es uno de los principales factores de riesgo independientes de enfermedad cardiovascular aterosclerótica (ECVA), junto con la hipertensión arterial (HTA), la dislipemia y la obesidad, que suelen presentarse de forma asociada [19]. La ECVA, en su definición, incluye los antecedentes de síndrome coronario agudo, infarto de miocardio, angina estable o inestable, revascularización coronaria u otra revascularización arterial, accidente cerebrovascular, accidente isquémico transitorio o enfermedad arterial periférica, incluido el aneurisma aórtico. Las complicaciones macrovasculares crónicas constituyen la principal de morbimortalidad en los pacientes con DM[20].

El estudio TODAY demostró un mayor riesgo de enfermedad cardiovascular en los pacientes jóvenes con DM tipo 2 [21,22]. Los pacientes adultos con diagnóstico de DM tipo

2 entre 15 y 30 años presentan el doble de mortalidad cardiovascular que aquellos con DM tipo 1 de la misma edad y duración del curso de la enfermedad[23]. Por otro lado, la DM 2 también se asocia a la aparición de insuficiencia cardiaca[24].

Los ensayos clínicos han demostrado que un tratamiento intensivo y control estricto de la DM, la HTA y la dislipemia en pacientes con DM tipo 2 reducen el riesgo de ECVA[25,26]. En ese sentido, la guía de la ADA establece una serie de medidas de cribado para la detección precoz de la hipertensión arterial y la dislipemia [27]. En pacientes con DM y con alto riesgo de insuficiencia cardíaca, ya sea asintomática o sintomática, se recomienda el cribado mediante la medición de péptidos natriuréticos [27]. También se recomienda realizar el cribado de enfermedad arterial periférica mediante índice tobillo-brazo en la población con riesgo[27].

4.2.6. Complicaciones crónicas microvasculares de la diabetes mellitus

La prevalencia de enfermedad renal crónica (ERC) atribuida a la DM en las personas con DM se sitúa entre 20-40%[28,29]. Suele aparecer tras unos 10 años de evolución en DM tipo 1; sin embargo, en la DM tipo 2 puede estar presente ya en el momento del diagnóstico. La presencia de ERC en pacientes con DM, tanto tipo 1 como tipo 2, aumenta de forma considerable el riesgo cardiovascular y el gasto sanitario[30]. En pacientes con DM se recomienda evaluar la función renal de forma rutinaria mediante la estimación de la tasa de filtrado glomerular y la medición de albuminuria[31].

La retinopatía diabética es la causa más frecuente de nuevos casos de ceguera en adultos entre 20 y 74 años de edad en los países desarrollados[32]. La prevalencia de retinopatía de cualquier tipo en las personas con DM es de un 35%, mientras que la prevalencia de retinopatía proliferativa es de un 7%[33]. El principal factor de riesgo es la duración de enfermedad, junto con la hiperglucemia crónica, la nefropatía, la HTA y la

dislipemia. El control estricto de la glucemia ha demostrado en los estudios prospectivos prevenir o retrasar la aparición o la progresión de la retinopatía diabética[34,35]. En la guía de la ADA, se recomienda realizar el cribado de retinopatía diabética mediante fondo de ojo en la DM tipo 1 a partir de 5 años de evolución y en la DM tipo 2 desde el momento del diagnóstico. Si no hay evidencia de retinopatía y buen control glucémico, se aconseja repetir el cribado cada 1-2 años [36].

La neuropatía diabética es un grupo heterogéneo de trastornos con diversas manifestaciones clínicas. Casi el 50% de los casos son asintomáticos, por lo que, si no se reconoce de forma precoz e inician medidas preventivas de cuidado de los pies, aumentan el riesgo de úlceras y amputaciones de los pies[37,38]. Por ello, se recomienda iniciar cribado de neuropatías diabéticas periféricas desde el diagnóstico de la DM tipo 2 o a los 5 años del diagnóstico de DM tipo 1, y posteriormente reevaluar de forma anual. El cribado incluye la prueba con monofilamentos de 10 g, la exploración de la sensibilidad al pinchazo y de la sensibilidad vibratoria mediante un diapasón de 128 Hz. Además se debe explorar la presencia de síntomas y signos de neuropatía autonómica[36].

4.2.7. Complicaciones agudas de la diabetes mellitus

La cetoacidosis diabética (CAD) y el estado hiperglucémico hiperosmolar (EHH) son las dos principales complicaciones de las crisis hiperglucémicas agudas, graves y potencialmente mortales en las personas con DM, las cuales aumentan significativamente la morbimortalidad y el gasto sanitario[39]. Representan aproximadamente el 1% de los ingresos hospitalarios en pacientes con DM[40]. En un estudio reciente, se reportó una mortalidad durante el ingreso por CAD del 0,2% en DM tipo 1 y del 1,04% en DM tipo 2. La mortalidad en pacientes hospitalizados por EHH ha

descendido del 1,44% en 2008 al 0,77% en 2018[41]. Se incluyen en el Anexo los criterios diagnósticos de CAD y EHH.

4.2.8. Comorbilidades de la diabetes mellitus

El manejo clínico de la DM requiere una evaluación integral sobre las complicaciones aguda y crónicas, así como las comorbilidades asociadas, dado que estas últimas afectan con mayor frecuencia a las personas con DM que a aquellas sin la enfermedad[42,43]. Además, dichas comorbilidades pueden dificultar el manejo de la DM[44].

- Obesidad: es una enfermedad crónica asociada a múltiples complicaciones metabólicas, físicas y psicosociales, con un riesgo significativo de desarrollar DM tipo 2[45]. Numerosos estudios han demostrado que la pérdida de peso retrasa la aparición de DM tipo 2, mejora el control glucémico, incluso puede inducir la remisión de la DM tipo 2[46–48]. El manejo terapéutico de la obesidad incluye la modificación de estilo de vida, la farmacoterapia y la cirugía metabólica o bariátrica. En su conjunto, ayudan a controlar el peso y mantener una pérdida ponderal significativa, reduciendo las complicaciones asociadas[49].
- Hipertensión arterial (HTA): es un factor de riesgo mayor para las ECVA, insuficiencia cardiaca y las complicaciones macrovasculares[50]. Varios estudios han demostrado la reducción de estas complicaciones con la terapia antihipertensiva[51–53]. La nueva guía de *American Heart Association* (AHA) y el *American College of Cardiology* (ACC) de 2025 mantiene la definición de HTA como cifras de tensión arterial ≥ 130/80 mmHg[54], un umbral más estricto que el establecido en las guías europeas de 2024 (≥ 140/90 mmHg) [55].
- Dislipemia: las personas con DM tipo 2 presentan una mayor prevalencia de dislipemias, lo que contribuye a un mayor riesgo de ECVA[56,57]. Múltiples ensayos

clínicos han demostrado el beneficio de las terapias con estatina en la reducción de estos eventos[58,59].

- Cáncer: la DM se asocia a un mayor riesgo de cáncer de hígado, páncreas, endometrio, colon, recto, mama y vejiga[60]. Esta asociación puede estar influida también por otros factores de riesgos como edad avanzada, obesidad y sedentarismo[61].
- Enfermedades autoinmunes: las personas con DM tipo 1 presentan un mayor riesgo de desarrollar otras enfermedades autoinmunes como la enfermedad tiroidea autoinmune, enfermedad celiaca, anemia perniciosa, enfermedad hepática autoinmune, insuficiencia suprarrenal primaria, vitíligo y miastenia gravis[62–64].
- Otras comorbilidades asociadas: enfermedad hepática esteatósica asociada a disfunción metabólica, alteraciones óseas, deterioro cognitivo o demencia, alteraciones dentales, apnea obstructiva de sueño, hepatitis C, pancreatitis, niveles bajos de testosterona en hombres, disfunción eréctil, disfunción sexual en mujeres y deterioro sensorial. Todas ellas requieren una anamnesis dirigida para su detección y una evaluación específica en presencia de síntoma o signos sugestivos.

4.3. Ejes de investigación de la Tesis

4.3.1. Cribados de cáncer ginecológico y colorrectal en la población española con diabetes

En España, el cáncer sigue siendo una de las principales causas de mortalidad, con una incidencia de nuevos casos de 279.260 en 2023, de los cuales, 42.721 fueron de origen colorrectal, 35.001 de cáncer de mama y 2.326 de cáncer de cérvix[65].

En los estudios previos, se estima un aumento de 1,2 a 1,5 veces en el riesgo relativo de padecer cáncer de mama y colorrectal en pacientes con DM tipo 2[61] y un riesgo

incrementado de cáncer de cérvix en aquellos con DM tipo 1[66,67]. Se han postulado como posibles mecanismos patogénicos el estado de hiperglucemia, el hiperinsulinismo y la obesidad, cuyo papel en el desarrollo del cáncer ginecológico y colorrectal está ampliamente documentado[66,68,69]:

- Hiperinsulinismo: los pacientes con DM tipo 2 presentan resistencia a la insulina, lo que provoca un estado de hiperinsulinismo que se asocia con unos niveles aumentado del factor de crecimiento similar a la insulina 1 (IGF-1). Este, a su vez, podría estimular la proliferación de varios órganos, incluyendo el colon y la mama[70–72].
- Hiperglucemia: podría contribuir con un exceso de aporte de glucosa a las células tumorales favoreciendo su proliferación. Asimismo, podría reducir la función de sistema inmunológico[73,74].
- Obesidad: existe una correlación entre la obesidad y el aumento de niveles de estrógenos, lo que incrementa el riesgo de cáncer de mama en mujeres postmenopáusicas[73].

Para la detección precoz de los cánceres más prevalentes, se han implementado en España, desde el año 1990 y de forma progresiva, diferentes programas de cribado para los cánceres de mama, cérvix y colorrectal[75].

Para el cribado del cáncer de mama, la prueba diagnóstica utilizada es la mamografía, que se realiza cada 2 años en mujeres de 50 a 69 años, y a partir de los 40 años en las mujeres con factores de riesgo[76]. El cribado de cáncer de cérvix se dirige a las mujeres de 25 a 64 años, mediante la citología cervical, también llamada prueba de Papanicolaou, que se realiza cada 3 años, y, desde el año 2019, se ha incorporado además la prueba de detección del virus del papiloma humano para esta población[77,78]. Por el último, el

cribado del cáncer colorrectal consiste en el análisis de sangre oculta en heces cada 2 años en personas mayores de 50 años [78].

Los sistemas de cribado oncológicos anteriormente descritos se han señalado como una herramienta eficaz de prevención secundaria para la mejora del pronóstico de la enfermedad [79,80]. Las directrices europeas estiman que al menos el 45% de la población diana debe someterse al cribado de cáncer colorrectal y el 70% al cribado de cánceres ginecológicos para poder observarse efectos beneficiosos significativos a nivel poblacional[81,82]. Sin embargo, en estudios previos, se ha observado una tendencia a un menor uso de programas de cribado de cáncer de mama y de cérvix en las mujeres con DM en las últimas décadas, a pesar del mayor riesgo de cánceres ginecológicos en estas pacientes[83,84]. De la misma manera, la DM se ha relacionado con una menor participación en el cribado del cáncer colorrectal[85].

Por lo tanto, es fundamental aconsejar a las personas con DM someterse a las pruebas de detección de cáncer recomendadas según su edad y sexo y reducir otros factores de riesgo de cáncer modificables como la obesidad, el sedentarismo y el tabaquismo.

4.3.2. Estilo de vida: dieta y actividad física en diabetes mellitus

El desarrollo de DM tipo 2 está influido por una combinación de susceptibilidad genética, estilo de vida, situación económica, factores sociopsicológicos y ambientales. La dieta de alta densidad energética, junto con un estilo de vida sedentario, se ha identificado como una de las causas primarias de la DM tipo 2[86]. Ambos factores son responsables de la pandemia de obesidad, la cual, a su vez, se asocia estrechamente con el aumento de la incidencia de DM tipo 2[87]. En un metaanálisis que evaluó la asociación entre estilo de vida y la incidencia de DM, se observó que las personas que tenían un estilo de vida más saludable presentaron un 75% menos riesgo de desarrollar la DM.

Dado que el estilo de vida es un factor modificable, existen múltiples estudios que analizan la prevención de la DM tipo 2 mediante intervenciones sobre el estilo de vida[88]. En un estudio prospectivo, cuyo objetivo principal fue lograr una pérdida moderada de peso a través de cambios en el estilo de vida, incluyendo medidas dietéticas y aumento de la actividad física, se documentó una reducción del 58% en la incidencia de DM en el grupo de intervención frente al grupo control tras 3-4 años de seguimiento[89].

Los estudios existentes confirman que diversos patrones de alimentación son aceptables para el manejo de la DM tipo 2. Los más frecuentemente recomendados incluyen la dieta mediterránea, la dieta para reducir la hipertensión arterial (dieta DASH, Enfoques Dietéticos para Detener la Hipertensión), la dieta baja en grasa, la dieta con restricción de carbohidratos, así como la dieta vegetariana y vegana [90–92]. Sin embargo, las evidencias disponibles actualmente son insuficiente para recomendar un único patrón de alimentación en concreto.

La dieta mediterránea ha sido declarada Patrimonio Cultural Inmaterial, ya que se asocia a un estilo de vida y a unos hábitos alimentarios particulares de la región del mar Mediterráneo[93–95]. Este patrón dietético se caracteriza por el uso preferente de aceite de oliva; una ingesta abundante de alimentos de origen vegetal; una mayor preferencia por la carne blanca magra; y un consumo moderado de pescado, cereales integrales y vino tinto[93,94]. No obstante, en los últimos años se ha observado una tendencia hacia una menor adherencia a este patrón, especialmente entre la población más joven, que lo ha ido sustituyendo por un mayor consumo de cereales refinados, carnes rojas, productos procesados y bebidas azucaradas[96–98].

En los estudios previos que analizaron el grado de adherencia a la dieta mediterránea en la población con DM en España, se observó un moderado nivel de adherencia. Entre

los factores predictores de una mayor adherencia se identificaron la edad avanzada, el sexo femenino, un alto nivel educativo y residir en la zona sur del país[99–101]. Otro estudio comparó el patrón de adherencia a la dieta mediterránea en España con el de cuatro países mediterráneos (Portugal, Italia, Grecia y Chipre) y otros dos no mediterráneos (Bulgaria y la Republica de Macedonia del Norte), utilizando los 14 ítems del sistema de cribado de adherencia a la dieta mediterránea, donde la población española mostró una mayor adherencia entre todos los países analizados[98]. Resultados similares se reportaron en otros estudios europeos, donde España presentó mejores niveles de adherencia a patrones dietéticos saludables [102,103].

La actividad física incluye todos movimientos que incrementan el gasto energético, mientras que el ejercicio es una forma más específica de actividad física, estructurada y diseñada para mejorar la condición física. El ejercicio ha demostrado mejorar el control glucémico, reducir los factores de riesgo cardiovascular y ayudar a controlar el peso[104]. La actividad aeróbica de intensidad moderada o alta se asocia con una menor mortalidad cardiovascular y por cualquier causa , tanto en la DM 1 como en la DM tipo 2[105]. Por otra parte, se ha evidenciado una fuerte asociación entre el sedentarismo, la obesidad y la DM, independiente del nivel de actividad física[106,107].

Un estudio realizado en España mostró un aumento en la adherencia a la actividad física de intensidad moderada o alta entre 2014 a 2020 en la población con DM, aunque sigue siendo menor en comparación con la población sin DM[108]. Se identificaron como predictores de baja actividad física la edad, el sexo femenino, el bajo nivel educativo, el tabaquismo y las comorbilidad como la obesidad, las enfermedades mentales y autopercepción desfavorable del estado de salud[108].

De acuerdo con la guía de la ADA, se recomienda a la mayoría de los adultos con DM tipo 1 y 2 realizar al menos 150 minutos semanales de actividad física de intensidad moderada a vigorosa, distribuidos en un mínimo de tres días por semana, evitando más de dos días consecutivos sin actividad[109]. En personas jóvenes se aconseja un mínimo de 60 minutos actividad física diarios, al menos tres días por semana, además de limitar el tiempo de sedentarismo. También se recomiendan 2 a 3 sesiones semanales de ejercicios de resistencia en días no consecutivos, y entrenamiento de flexibilidad y de equilibrio 2 a 3 veces por semana en adultos mayores con DM[109].

4.3.3. Utilización de recursos sanitarios en personas con diabetes mellitus

Según la 11ª edición de *Diabetes Atlas* de la IDF, en 2024 el gasto promedio por persona con DM en España fue de 2.808,90 dólares, alcanzando un total estimado de 13,1 mil millones de dólares. En comparación, un estudio realizado en 2009, que estimó el coste directo de la DM tipo 2 a partir de cuatro estudios de costes en España, calculó un gasto de 5,1 mil millones de euros en costes directos, junto con 1,4 mil millones de euros atribuibles a complicaciones relacionadas con la DM. En conjunto representaba el 8% del gasto total del Sistema Nacional de Salud(SNS)[110].

En un estudio poblacional retrospectivo realizado en Cataluña en 2011, que estimó los gastos médicos directos asociados a la DM tipo 2, se observó un promedio de gasto anual por pacientes de 3.110 euros en personas con DM frente a 1.806 euros en aquellas sin enfermedad. El mayor componente del gasto correspondió a hospitalizaciones (41.9%) y medicación (29.7%). Además, los pacientes con DM y HbA1c > 7% presentaron un gasto promedio superior al de aquellos con buen control glucémico (3.296 euros frente a 2.858 euros)[111]. Otro estudio poblacional de prevalencia, realizado en Países

Vascos, estimó gasto sanitario anual promedio de 3.432 en personas con DM, siendo 161 euros más elevado en hombres en comparación con mujeres[112].

El SNS en España ofrece cobertura universal, financiado principalmente mediante impuestos[113,114]. La cartera de servicios es amplia, si bien se exige copago en medicamentos; sin embargo, los pagos directos no suelen representar un gasto inasumible para los hogares[113,114]. Por lo que estos datos adquieren especial relevancia en el contexto de España, por requerir un consumo importante de la atención sanitaria, generando una presión creciente sobre los recursos disponibles. Esta situación se ve agravada también por el envejecimiento progresivo de la población, factor que incrementa la prevalencia de enfermedades crónicas como la diabetes, y, en consecuencia, la demanda de recursos sanitarios especializados[113,115].

Desde el punto de vista clínico, la DM conlleva tanto complicaciones agudas como crónicas que incrementan la necesidad de atención sanitaria. Las descompensaciones agudas, como la cetoacidosis diabética, el síndrome hiperglucémico hiperosmolar o la hipoglucemia, son causas frecuentes de consulta en servicios de urgencias[116]. A largo plazo, la DM se asocia a un mayor riesgo de enfermedad cardiovascular y cerebrovascular, incluyendo cardiopatía isquémica, ictus y enfermedad arterial periférica[117,118], que podrían conllevar un incremento de las hospitalizaciones y del seguimiento en consultas especializadas[119]. En el ámbito de las complicaciones microvasculares, la nefropatía diabética constituye la primera causa de tratamiento renal sustitutivo en España, con una importante repercusión sobre el gasto sanitario[120,121]. Asimismo, la coexistencia de múltiples patologías crónicas en personas con DM, como hipertensión arterial, dislipemia o enfermedad mental, aumenta aún más

la utilización de los servicios sanitarios y complica la gestión clínica de estos pacientes[43,118].

En un estudio que abarcó el periodo 1997 a 2020,se observó un incremento de 2.6 veces el número de hospitalización por todas las causas entre pacientes con DM[122]. Sin embargo, en otro estudio realizado entre periodo 2007 y 2015, reportó un descenso en las hospitalizaciones relacionadas con DM en España.

Por otro lado, debe señalarse que la Encuesta Nacional de Salud edición 2020 recogió información desde julio de 2019 hasta julio de 2020. A partir de marzo de 2020, debido al estado de alarma por la pandemia de COVID-19, el método de recogida de datos pasó de entrevistas presenciales a telefónicas. Este hecho podría haber influido en la evaluación de la utilización de recursos sanitarios en este periodo, ya que diversos estudios han evidenciado una menor utilización de la atención médica entre personas con DM, un aumento de uso de telemedicina y retraso en la prestación de servicios sanitarios durante la pandemia [123,124].

4.4. Marco conceptual

La DM constituye un importante problema de salud pública por su elevada prevalencia, su asociación con múltiples complicaciones y comorbilidades, y el elevado consumo de recursos sanitarios que general. La literatura revisada muestra que la DM se relaciona con resultados adversos en distintos ámbitos, que abarcan la prevención secundaria de cánceres prevalentes, los estilos de vida y la utilización de servicio de salud.

En primer lugar, la evidencia disponible indica que las personas con DM presentan un riesgo aumentado de desarrollar determinados cánceres, en particular el colorrectal y los ginecológicos, a la vez que muestran menores tasas de participación en programas de cribado oncológicos.

En segundo lugar, los estilos de vida, en especial la dieta y actividad física, constituye determinantes modificables estrechamente relacionados con el desarrollo de DM. La adherencia a patrones dietéticos saludable y la práctica regular de actividad física se asocian con un mejor control glucémico y un menor riesgo de complicaciones.

En tercer lugar, la DM representa un elevado coste para el SNS, tanto por los gastos directos derivados de la hospitalizaciones, consultas y tratamiento farmacológicos, como por los costes indirectos asociados a la pérdida de productividad laboral. Todo ello incrementa la utilización de recursos sanitarios y generan una carga creciente sobre un sistema sanitario ya presionado por el envejecimiento poblacional.

Sobre la base de estos tres ejes se construye el presente modelo conceptual, que proporciona el fundamento teórico para la formulación de las hipótesis de la tesis, en las que se plantea explorar cómo interactúan dichos factores y de qué manera condicionan los resultados en salud de las personas con DM.

5. HIPÓTESIS

1. La población con DM presenta una menor adherencia a los cribados de cánceres ginecológicos y colorrectales, a pesar de tener un mayor riesgo de desarrollar cáncer, en comparación con la población general.

2. La población con DM presenta una mejor adherencia a las recomendaciones nutricionales y de actividad física, de acuerdo con las indicaciones médicas.

3. Los individuos con DM utilizan con mayor frecuencia los recursos sanitarios, tanto hospitalización como visitas a urgencias, que aquellos sin DM, dado que se trata de una patología asociada a más comorbilidades, que requieren atención sanitaria.

6. OBJETIVOS

1. Analizar la tendencia temporal de adherencia a los cribados de cánceres ginecológicos y colorrectal en la población con DM entre 2014 y 2020.

2. Comparar el grado de adherencia a los cribados de cánceres ginecológicos y colorrectales entre la población con y sin DM.

3. Identificar los factores predictores de adherencia a los cribados de cáncer ginecológico y colorrectal en la población con DM.

4. Describir y comparar los hábitos dietéticos y nivel de actividad física entre los individuos con y sin DM.

5. Identificar los factores predictores de mayor adherencia a las recomendaciones dietéticas en la población con DM.

6. Analizar la evolución de hospitalización y visitas a urgencias en las personas con DM de 2014 a 2020.

7. Comparar la utilización de recursos sanitarios entre la población con y sin DM, considerando variables sociodemográficas, de estilos de vida y comorbilidades.

8. Identificar los factores predictores de mayor consumo de recursos sanitarios en la población con DM.

7. Material y métodos

7.1. Diseño de los estudios

Se realizaron tres estudios observacionales retrospectivos de casos y controles, utilizando datos de las ediciones 2014 y 2020 de la Encuesta Europea de Salud en España (EHISS). Esta encuesta, llevada a cabo por el Instituto Nacional de Estadística (INE) en colaboración con el Ministerio de Sanidad, tiene como objetivo recopilar información sobre el estado de salud de la población residente en España, incluyendo determinantes de la salud y uso de recursos sanitarios[125]. La EHISS se realiza periódicamente y está dirigida a la población mayor de 15 años. Los datos se obtuvieron mediante entrevistas personales en el domicilio, excepto en parte de la edición de 2020, donde se realizaron entrevistas telefónicas desde el mes de marzo a julio debido a la pandemia de COVID-19. La consistencia metodológica entre diferentes ediciones garantiza la comparabilidad de los resultados[125].

El diseño muestral de la EHISS fue probabilístico, estratificado y multietápico. En primer lugar, se seleccionaron aleatoriamente unidades geográficas (secciones censales), seguidas de una muestra aleatoria de viviendas, y finalmente se eligió un individuo por hogar. Este procedimiento garantiza la representatividad de la población general española[125].

7.2. Selección de casos y controles

Se consideraron como casos aquellos participantes que respondieron afirmativamente a la pregunta: "¿Le ha dicho un médico que tiene diabetes?". Cada caso fue emparejado con un control quien contestó negativamente a la misma pregunta, ajustando por sexo, edad, edición de la encuesta y comunidad autónoma de residencia, con el objetivo de reducir posibles factores de confusión.

7.3. Variables recogidas

Las variables dependientes de cada estudio fueron los siguientes:

1. Adherencia a cribados oncológicos:

a. Mamografía: participantes que había realizado una mamografía en los dos años previos. Se incluyeron mujeres de 40 años o más.

b. Citología: participantes que había realizado una citología en los tres años previos. Se incluyeron mujeres de 18 a 69 años.

c. Prueba de sangre oculta en heces: individuos que había realizado esta prueba en los dos años previos. Se incluyeron hombres y mujeres de 50 a 69 años.

2. Adherencia a recomendaciones nutricionales y actividad física:

a. Frecuencia de consumo de alimentos: se utilizó el cuestionario de frecuencia de consumo de alimentos de la edición 2020[126]. Se analizó la frecuencia de consumo de nueve grupos de alimentos, incluidos frutas y verduras, carne, huevos, pescado, legumbres, pasta, arroz y patatas, pan y cereales, productos lácteos y refrescos azucarados. Las "ingestas recomendadas" por cada grupo de alimentos fueron las publicadas en el año 2022 por la Agencia Española de Seguridad Alimentaria y Nutrición en el documento titulado "Informe de Comité Científico de la Agencia Española de Seguridad Alimentaria y Nutrición sobre recomendaciones dietéticas sostenibles y recomendaciones de actividad física para la población española"[127].

b. Frecuencia de actividad física (AF): se clasificó como sedentario o de AF baja a quienes respondieron "no hago ejercicio" o "realizo AF o actividades deportivas ocasionalmente". Se consideró como AF moderada o alta cuando respondieron "participo en AF varias veces al mes" o "realizo entrenamiento atlético o físico varias veces por semana".

3. Uso de recursos sanitarios:

a. Hospitalización: participantes que reportaron haber sido hospitalizados al menos una vez en los últimos doce meses.

b. Visita a Urgencias: aquellos participantes que refirieron haber acudido a los servicios de Urgencias en los últimos doce meses.

Las variables independientes se clasificaron en tres grupos:

1. Variables sociodemográficas: género, edad, nivel educativo, convivencia y edición de la encuesta.
2. Variables de estilo de vida: índice de masa corporal (IMC), autopercepción de salud, sedentarismo, y antecedentes de accidentes.
3. Variables de comorbilidades: enfermedad pulmonar obstructiva crónica (EPOC), asma, infarto de miocardio, ictus, cáncer, enfermedad mental, hipertensión arterial, dislipemia, dolor crónico, osteoporosis, úlcera gastroduodenal y enfermedad periodontal.

La descripción detallada de las preguntas usada para crear las variables de estudio, así como la categorización según las posibles respuestas se encuentran detalladas en la Tabla suplementaria.

7.4. Análisis estadístico

Se realizó un análisis descriptivo de los variables sociodemográficos, del estilo de vida y de comorbilidades. Las variables cuantitativas con distribución normal se representaron mediante media y desviación estándar (DM), mientras que aquellas que no presentaban distribución normal fueron representadas en forma de mediana y rango intercuartílico (RIC). Por otro lado, las variables cualitativas se mostraron en forma de frecuencia y porcentaje.

Las comparaciones se efectuaron utilizando la prueba de Student o la U de Mann-Whitney para variables cuantitativas según su ajuste a la distribución normal y la prueba chi-cuadrado para variables cualitativas.

Con el objetivo de identificar los factores predictores, se desarrollaron los modelos de regresión logística multivariante correspondientes para cada estudio. En los modelos se incluyeron variables independientes que mostraron asociación significativa en los análisis bivariados y aquellas consideradas relevantes según la literatura. El peso de cada variable se evaluó mediante el estadístico de Wald eliminando aquellas que no contribuían de forma significativa. La colinealidad se evaluó utilizando el factor de inflación de varianza. El ajuste del modelo se evaluó mediante la prueba de Hosmer-Lemeshow. Finalmente, se representaron las odds ratios (OR) con sus intervalos de confianza (IC) del 95% correspondientes. Se consideró estadísticamente significativo un valor de $p<0,05$ bilateral.

Todos los análisis se realizaron utilizando SPSS versión 26.0 (IBM Corp., Armonk, Nueva York, EE.UU.).

7.5. Aspectos éticos

Los estudios se basaron en datos obtenidos de la EHISS, que garantiza la confidencialidad y anonimato de los participantes de acuerdo con las normativas éticas y legales vigentes. Dado que los datos estuvieron anonimizados y no contenían información que permita identificar a los individuos, no fue necesaria la aprobación por un Comité de Ética de Investigación con medicamentos ni obtener el consentimiento informado a los participantes. La descarga de las bases de datos de la EHISS se puede realizar libremente desde la web del INE.

8. ARTÍCULOS PUBLICADOS

8.1. Artículo 1

"Adherence to Screening Tests for Gynaecological and Colorectal Cancer in Patients with Diabetes in Spain: A Population-Based Study (2014-2020)"

Luyi Zeng-Zhang, Javier de Miguel-Diez, Ana López-de-Andrés, Rodrigo Jiménez-García, Zichen Ji, Olalla Meizoso-Pita, Cristina Sevillano-Collantes, Jose J Zamorano-León.

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Adherence to Screening Tests for Gynaecological and Colorectal Cancer in Patients with Diabetes in Spain: A Population-Based Study (2014–2020)

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Abstract: Objectives: Both diabetes mellitus (DM) and gynaecological and colorectal cancers are highly prevalent diseases. Furthermore, the presence of DM constitutes a risk factor and poor prognostic indicator for these types of cancer. This study is based on the European Health Interview Surveys in Spain (EHISS) of 2014 and 2020. It aimed to determine the trends in adherence to screening tests for gynaecological cancers (breast and cervical) and colorectal cancer, compare adherence levels between populations with and without diabetes, and identify predictors of adherence in the population with diabetes. **Methods**: An epidemiological case-control study based on the EHISS data of 2014 and 2020 was conducted. The characteristics of participants who underwent screening tests were analysed based on the presence or absence of DM, and predictors of adherence to these preventive activities were identified. **Results**: A total of 1852 participants with reported DM and 1852 controls without DM, adjusted for age and sex, were included. A higher adherence to mammography was observed in women without diabetes compared to those with diabetes, although statistical significance was not reached (72.9% vs. 68.6%, $p = 0.068$). Similarly, higher Pap smear adherence was observed in the population without diabetes in the age group between 60 and 69 years compared to the population with diabetes (54.0% vs. 45.8%, $p = 0.016$). Pap smear adherence among women with diabetes was significantly higher in the EHISS of 2020 (52.0% in 2014 vs. 61.0% in 2020, $p = 0.010$), as was the case for faecal occult blood testing (13.8% in 2014 vs. 33.8% in 2020, $p < 0.001$), but it was not significant for mammography (70.4% in 2014 vs. 66.8% in 2020, $p = 0.301$). Overall, the predictors of adherence to screening tests were older age, history of cancer and higher education level. **Conclusions**: Adherence levels to cancer screening tests were lower in the population with diabetes compared to those without diabetes, although an improvement in Pap smear and faecal occult blood test adherence was observed in 2020 compared to 2014. Understanding predictors is important to improve adherence rates in the population with diabetes.

Keywords: diabetes mellitus; screening tests; gynaecological cancer; colorectal cancer

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1. Introduction

Diabetes mellitus (DM) is among the most prevalent chronic diseases in the Spanish population, with its prevalence doubling in recent years from 7.6% to 14.8%, positioning Spain as the country with the second-highest prevalence in Europe [1]. It is associated with the presence of multiple comorbidities, including various types of cancer [2]. Specifically, an estimated 1.2- to 1.5-fold increase in the relative risk of developing breast and colorectal

cancer (CRC) has been observed in patients with type 2 DM, alongside an increased risk of cervical cancer in those with type 1 DM. Hyperglycaemia, hyperinsulinism and the association with obesity have been postulated as possible pathogenic mechanisms whose role in the development of gynaecological and CRC is widely known [3,4].

In Spain, cancer remains a leading cause of mortality, with a reported incidence of 279,260 new cases in 2023. Of these, 42,721 were CRC, 35,001 were breast cancer and 2326 were cervical cancer [5].

To facilitate early detection of the most prevalent cancers, various screening programmes for breast, cervical and CRC have been progressively implemented in Spain since 1990 [6]. Mammography is used for breast cancer screening in women aged 50 to 69 years, and from 40 years onward for those with risk factors, with screenings scheduled every two years [7]. Cervical cancer screening targets women aged 25 to 64 years through cervical cytology, also known as the Papanicolaou (Pap) smear, conducted every three years. Since 2019, human papillomavirus testing has been incorporated into cervical cancer screening [8,9]. Lastly, CRC screening involves faecal occult blood testing (FOBT) for individuals over 50 years old, recommended biennially [9].

These oncological screening systems have been recognised as effective tools for secondary prevention, enhancing disease prognosis [10,11]. European guidelines stipulate that at least 45% of the target population should undergo CRC screening, and 70% should undergo gynaecological cancer screening, to observe significant beneficial effects at the population level [12,13]. However, previous studies have noted a declining trend in the utilisation of breast and cervical cancer screening programmes among women with DM over the past decades, despite their heightened risk of gynaecological cancers [14].

Therefore, this study aimed to ascertain the temporal trend in adherence to screening tests for gynaecological and CRC based on the European Health Interview Surveys in Spain (EHISS) from 2014 to 2020. It also sought to compare adherence levels between populations with and without diabetes and identify healthcare, sociodemographic and lifestyle variables predictive of adherence to oncological screening programmes among individuals with diabetes.

2. Materials and Methods

2.1. Design

An observational, retrospective, case-control epidemiological study was conducted using data from the EHISS for 2014 and 2020. In Spain, the EHISS was conducted by the National Statistics Institute under the coordination and supervision of the Ministry of Health. This programme involved personal interviews with a representative sample of the non-institutionalised population aged 15 or older residing in Spain. Participants were selected through multistage probability sampling, with primary-stage units being census sections and secondary-stage units being main family households.

Surveys conducted in 2014 were in-person, whereas those in 2020 were initially in-person until March, then transitioned to telephone interviews due to the impact of the COVID-19 pandemic.

The methodology employed for the EHISS has remained consistent across different editions, enabling the comparison of results obtained in different years, and is detailed by the Spanish National Statistics Institute [15].

2.2. Selection of Cases and Controls

All participants reporting a medical diagnosis of DM were classified as cases. Individuals were categorised as cases if they answered affirmatively to the question: "Has a doctor ever diagnosed you with diabetes?" Participants reporting no DM were considered controls. One control was randomly assigned for each case, considering the edition of the EHISS in which they participated, as well as sex, age and place of residence.

2.3. Variables

Three dependent variables were selected. The first, mammography as a preventive practice, was assessed by asking participants whether they had undergone a mammogram in the previous two years. The age interval considered suitable for mammography was 40 years or older. The second variable, Pap smear usage, was evaluated by asking participants whether they had undergone a Pap smear in the previous three years. Women aged 18 to 69 years were considered eligible for Pap smear. Lastly, adherence to CRC screening was determined by whether individuals had undergone FOBT in the past two years, with individuals not adhering classified as non-adherents. Both men and women aged 50 to 69 years were considered eligible for FOBT. All variables were derived from questions included in the EHISS, and data were thus self-reported by participants.

The independent variables were:

1. Demographic and clinical characteristics: sex, age, education level, living with a partner, self-rated health and body mass index (BMI).
2. Concomitant diseases: chronic obstructive pulmonary disease (COPD), cardiac ischemia, stroke, cancer, mental illness and high blood pressure (HBP).
3. Risk habits: alcohol consumption, active smoking and sedentary lifestyle.

Detailed descriptions and categories of these variables are presented in Table S1.

2.4. Endpoints

The primary endpoints of this study are the following:

1. To establish the temporal trends in adherence to gynecological cancer screening tests and CRC screening tests across the Spanish population using data from the EHISS for the period 2014 to 2020. We will measure adherence as the proportion of the targeted population that completed the recommended screening tests during the aforementioned timeframe.
2. To compare the adherence rates to these screening tests between individuals with and without diabetes. This analysis will involve calculating the percentage of individuals in each group who have undergone the recommended screenings within the prescribed intervals.
3. To identify the key healthcare, sociodemographic and lifestyle predictors of adherence to oncological screening programs among individuals with diabetes. For this, we will perform multivariate logistic regression analyses to determine which factors significantly influence adherence rates, incorporating all independent variables of demographic and clinical characteristics, concomitant diseases and risk habits.

2.5. Statistical Analysis

The distribution of the sample of women undergoing breast and cervical cancer screening, as well as men and women undergoing FOBT, was described. All quantitative variables had a normal distribution and were expressed as mean and standard deviation (SD). Qualitative variables were represented as frequency and percentage.

For the comparisons made, quantitative variables were studied using analysis of variance or Student's *t*-test, and qualitative variables were analysed using the chi-square test. Adherence to the three tests was analysed based on the independent variables of the study, according to the presence or absence of diabetes.

Multivariable analyses were performed using logistic regression; three models were generated based on the absence or presence of diabetes for each oncological screening programme. These models allowed us to evaluate the adjusted change from 2014 to 2020 and predictors of adherence to breast, cervical and CRC screening programmes. The models included variables with a significant association in bivariate analysis or those reported as relevant in the literature.

The level of statistical significance was set at $p < 0.05$ for all comparisons. All statistical analysis was conducted using SPSS version 26.0.

2.6. Ethical Considerations

EHISS data are freely accessible and available on the official website of the Ministry of Health of Spain. Because these are anonymised data, according to Spanish legislation, approval by an ethics committee was not required to conduct this study.

3. Results

3.1. Characteristics of Population with Diabetes According to EHISS Surveys to Assess Adherence to Oncological Screening Programmes

Table 1 depicts the distribution of demographic characteristics, comorbidities, risk habits and performance of screening tests among cases based on the year of EHISS completion. This study included 1852 cases diagnosed with DM and 1852 age-, sex-, EHISS edition- and residence-matched controls. Among the cases, 941 participants (50.8%) were from the 2014 EHISS and 911 (49.2%) belonged to the 2020 EHISS. Of the 2014 EHISS cases, 531 (56.4%) were male and for the 2020 EHISS, this figure was 521 (57.2%), with no significant differences observed. The mean age of cases from the 2014 and 2020 EHISS was also similar at 57.7 years (SD 9.7) and 58.4 years (SD 9.1), respectively (Table 1).

Table 1. Distribution according to study variables of people with diabetes diagnosis included in the European Health Interview Surveys for Spain (EHISS) conducted in the years 2014 and 2020.

Variable	Categories	EHISS 2014 (N = 941)		EHISS 2020 (N = 911)		*p*-Value
		n	%	n	%	
Gender	Male	531	56.4	521	57.2	0.741
	Female	410	43.6	390	42.8	
Age (Years old)	Mean (SD)	57.7 (9.7)		58.4 (9.1)		0.143
Age groups (Years old)	18–39	57	6.1	49	5.4	0.204
	40–49	117	12.4	87	9.5	
	50–59	274	29.1	280	30.7	
	60–69	493	52.4	495	54.3	
Education level	No studies/primary	140	14.9	99	10.9	0.009
	Secondary	707	75.1	694	76.2	
	High education	94	10.0	118	13.0	
Living with a partner	Yes	622	66.1	571	62.7	0.105
Self-rated health	Fair/poor/very poor	397	42.2	429	47.1	<0.034
	Very good/good	544	57.8	482	52.9	
COPD	Yes	118	12.5	111	12.2	0.816
Cardiac ischemia	Yes	81	8.6	75	8.2	0.771
Stroke	Yes	37	3.9	33	3.6	0.727
Cancer	Yes	65	6.9	61	6.7	0.857
Mental disease	Yes	216	23.0	174	19.1	0.042
High blood pressure	Yes	511	54.3	485	53.2	0.646
Alcohol consumption	Yes	508	54.0	431	47.3	0.174
Active smoking	Yes	238	25.3	228	25.0	0.896

Table 1. *Cont.*

Variable	Categories	EHISS 2014 (N = 941)		EHISS 2020 (N = 911)		*p*-Value
		n	%	n	%	
Sedentary lifestyle	Yes	402	42.7	369	40.5	0.379
Body mass index (kg/m^2)	<25	185	20.5	210	23.8	0.037
	25–29.9	361	40.1	374	42.4	
	≥30	355	39.4	298	33.8	
Mammography (<2 years)	Yes	266	70.4	244	66.8	0.301
Pap smear (<3 years)	Yes	213	52.0	238	61.0	0.010
FOBT (<2 years) total	Yes	106	13.8	262	33.8	<0.001
FOBT (<2 years) men	Yes	63	14.4	195	35.9	<0.001
FOBT (<2 years) women	Yes	43	13.1	67	28.9	<0.001

The predominant education level was secondary education, with 707 participants (75.1%) in the 2014 EHISS and 694 (76.2%) in the 2020 EHISS, showing a different distribution of primary and university education between the two surveys. More than half of the cases lived with a partner, specifically, 622 (66.1%) in the 2014 EHISS and 571 (62.7%) in the 2020 EHISS. Most participants perceived their health status as good or very good, specifically, 544 (57.8%) in the 2014 EHISS and 482 (52.9%) in the 2020 EHISS, significantly higher in the 2014 EHISS. The most frequent comorbidity was HBP, with 511 participants (54.3%) in the 2014 EHISS and 485 (53.2%) in the 2020 EHISS. Significant differences were also observed in BMI distribution, with more obesity among individuals with diabetes in 2014 (Table 1).

Regarding the performance of screening tests, no significant differences were observed in the breast cancer programme: 266 women (70.4%) in 2014 and 244 (66.8%) in 2020 reported having undergone mammography in the two years preceding the survey. However, the Pap smear adherence rate among women with diabetes was significantly higher in 2020 (52.0% in 2014 vs. 61.0% in 2020, $p = 0.010$). Conversely, a significant increase was seen in individuals with diabetes reporting having undergone FOBT in the two years before the 2020 survey compared to the 2014 survey (13.8% in 2014 vs. 33.8% in 2020, $p < 0.001$). This increase in FOBT adherence in 2020 was observed in both sexes (Table 1).

3.2. Comparison of Mammography Adherence Rates between Women with and without Diabetes according to Sociodemographic, Health and Lifestyle Variables

Table 2 displays the comparison of characteristics of participants who reported undergoing mammography based on the presence or absence of DM. The results revealed higher adherence among women without diabetes, although the difference was not statistically significant. Moreover, greater adherence was observed in women without diabetes who perceived their health status as good or very good, compared to women with diabetes (72.3% vs. 70.3%, $p = 0.031$). In this regard, a higher proportion of adherence to mammography was found in women without diabetes who reported no cardiac ischemia (73.3% vs. 68.3%, $p = 0.041$), cancer (72.2% vs. 66.9%, $p = 0.035$), HBP (71.7% vs. 63.3%, $p = 0.009$), or overweight or obesity (BMI < 25 kg/m^2; 72.6% vs. 60.6%, $p = 0.006$) compared to women with diabetes. Similarly, women without diabetes with active smoking habits showed greater adherence to mammography compared to women with diabetes (74.5% vs. 62.5%, $p = 0.026$).

Table 2. Prevalence of Spain's resident population with and without diabetes who underwent screening for breast according to sociodemographic, clinical and lifestyle features.

Variables	Categories	Mammography Last 2 Years						
		No Diabetes		Diabetes		Both		*p*-Value
		n	%	n	%	n	%	
Gender	Male	-	-	-	-	-	-	-
	Female	542	72.9	510	68.6	1052	70.8	0.068
Age groups (years old) [A,B,C]	18–39	-	-	-	-	-	-	-
	40–49	43	49.4	31	35.6	74	42.5	0.066
	50–59	185	79.7	174	75.0	359	77.4	0.222
	60–69	314	74.1	305	71.9	619	73.0	0.486
Education level	No studies/primary	45	65.2	87	64.9	132	65.0	0.967
	Secondary	400	73.9	368	69.0	768	71.5	0.076
	High education	97	72.9	55	72.4	152	72.7	0.930
Living with a partner [A,C]	No	342	76.0	312	70.7	654	73.4	0.426
	Yes	199	68.9	198	65.8	397	67.3	0.076
Self-rated health	Fair/poor/very poor	336	73.4	177	65.8	513	70.6	0.551
	Very good/good	206	72.3	333	70.3	539	71.0	0.031
COPD	No	493	73.5	430	68.9	923	71.3	0.070
	Yes	49	68.1	80	67.2	129	67.5	0.906
Cardiac ischemia	No	534	73.3	477	68.3	1011	70.8	0.041
	Yes	8	57.1	33	73.3	41	69.5	0.251
Stroke	No	538	73.3	495	68.8	1033	71.0	0.056
	Yes	4	44.4	15	65.2	19	59.4	0.282
Cancer [B,C]	No	495	72.2	453	66.9	948	69.6	0.035
	Yes	47	82.5	57	86.4	104	84.6	0.550
Mental disease	No	421	71.7	345	67.9	766	70.0	0.171
	Yes	121	77.6	165	70.2	286	73.1	0.108
High blood pressure [B,C]	No	388	71.7	212	63.3	600	68.5	0.009
	Yes	154	76.2	298	73.0	452	74.1	0.396
Alcohol consumption [A]	No	286	69.8	369	68.1	655	68.8	0.581
	Yes	256	76.9	140	70.4	396	74.4	0.095
Active smoking	No	429	72.5	415	70.2	844	71.3	0.404
	Yes	113	74.8	95	62.5	208	68.6	0.026
Sedentary lifestyle	No	348	73.3	285	71.6	633	72.5	0.585
	Yes	194	72.4	225	65.2	419	68.4	0.058
Body mass index (kg/m^2)	<25	238	72.6	103	60.6	341	68.5	0.006
	25–29.9	184	76.0	177	71.4	361	73.7	0.241
	≥30	95	73.1	200	71.7	295	72.1	0.770
EHISS	2014	280	74.1	266	70.4	546	72.2	0.146
	2020	262	71.8	244	66.8	506	69.3	0.086

[A]: Significant association for population without diabetes; [B]: Significant association for population with diabetes; [C]: Significant association for both. *p*-value represents comparison of frequencies between non-diabetes and diabetes populations.

Variables such as age, living with a partner and alcohol consumption were associated with mammography adherence in the group of women without diabetes, whereas age, cancer diagnosis and HBP were significantly associated with undergoing mammography in

women with diabetes. For the total population, age, living with a partner, cancer diagnosis and HBP were associated with adherence to breast cancer screening.

3.3. Comparison of Pap Smear Adherence Rates between Women with and without Diabetes according to Sociodemographic, Health and Lifestyle Variables

Table 3 presents the data comparing the characteristics of patients who reported undergoing Pap smears, depending on the presence or absence of DM. A higher adherence was observed in the population without diabetes in the age group between 60 and 69 years compared to the population with diabetes (54.0% vs. 45.8%, $p = 0.016$). Regarding comorbidities, a higher percentage of women without diabetes undergoing Pap smears reported no COPD (61.8% vs. 56.4%, $p = 0.041$), no cancer (68.4% vs. 49.3%, $p = 0.031$) and no HBP (60.0% vs. 49.6%, $p = 0.015$) compared to the population with diabetes. Conversely, for those reporting mental illness, the highest adherence percentage was observed among women with diabetes (61.2% vs. 56.2%, $p = 0.005$).

Table 3. Prevalence of Spain's resident population with and without diabetes who underwent screening for cervix cancer according to sociodemographic, clinical and lifestyle features.

Variables	Categories	Pap Smear Last 3 Years						
		No Diabetes		Diabetes		Both		*p*-Value
		n	%	n	%	n	%	
Gender	Male	-	-	-	-	-	-	-
	Female	489	61.1	451	56.4	940	58.8	0.054
Age groups (years old) [A,B,C]	18–39	38	66.7	41	71.9	79	69.3	0.542
	40–49	60	69.0	65	74.7	125	71.8	0.399
	50–59	162	69.8	151	65.1	313	67.5	0.276
	60–69	229	54.0	194	45.8	423	49.9	0.016
Education level [A,B,C]	No studies/primary	20	28.6	54	39.4	74	35.7	0.124
	Secondary	353	61.5	334	58.2	687	59.8	0.253
	High education	116	74.4	63	70.8	179	73.1	0.544
Living with a partner [C]	No	308	64.2	280	58.8	588	61.5	0.347
	Yes	179	56.6	171	52.9	350	54.8	0.090
Self-rated health [A,C]	Fair/poor/very poor	324	63.9	177	57.8	501	61.6	0.817
	Very good/good	165	56.3	274	55.5	439	55.8	0.085
COPD	No	446	61.8	380	56.4	826	59.2	0.041
	Yes	43	55.1	71	56.3	114	55.9	0.864
Cardiac ischemia [A,C]	No	485	61.7	429	56.9	914	59.4	0.055
	Yes	4	28.6	22	47.8	26	43.3	0.203
Stroke [A,C]	No	487	61.6	441	56.8	928	59.2	0.056
	Yes	2	22.2	10	41.7	12	36.4	0.301
Cancer	No	450	60.6	418	57.0	868	58.8	0.167
	Yes	39	68.4	33	49.3	72	58.1	0.031
Mental disease	No	398	62.4	303	54.3	701	58.6	0.318
	Yes	91	56.2	148	61.2	239	59.2	0.005
High blood pressure [B,C]	No	366	61.5	244	63.7	610	62.4	0.489
	Yes	123	60.0	207	49.6	330	53.1	0.015

Table 3. *Cont.*

Variables	Categories	Pap Smear Last 3 Years						
		No Diabetes		Diabetes		Both		*p*-Value
		n	%	n	%	n	%	
Alcohol consumption [A,C]	No	252	57.0	317	54.3	569	55.5	0.383
	Yes	237	66.2	133	62.1	370	64.7	0.327
Active smoking [C]	No	381	60.0	343	54.7	724	57.4	0.057
	Yes	108	65.5	108	62.4	216	63.9	0.562
Sedentary lifestyle [A,B,C]	No	328	64.2	258	60.3	586	62.4	0.218
	Yes	161	55.7	193	51.9	354	53.6	0.328
Body mass index (kg/m^2) [A,B,C]	<25	245	67.1	120	62.5	365	65.5	0.275
	25–29.9	154	60.9	147	55.9	301	58.3	0.252
	≥30	72	51.8	164	55.4	236	54.3	0.481
EHISS [B,C]	2014	238	58.0	213	52.0	451	55.0	0.079
	2020	251	64.4	238	61.0	489	62.7	0.336

[A]: Significant association for population without diabetes; [B]: Significant association for population with diabetes; [C]: Significant association for both. *p*-value represents comparison of frequencies between non-diabetes and diabetes populations.

Variables such as age, education level, self-rated health, diagnosis of cardiac ischemia, stroke, alcohol consumption, sedentary lifestyle and BMI were associated with Pap smear adherence in the women without diabetes group, whereas variables such as age, education level, diagnosis of HBP, sedentary lifestyle, BMI and survey year were significantly associated with undergoing Pap smear testing in women with diabetes. For the total population, age, education level, living with a partner, self-rated health, diagnosis of cardiac ischemia, history of stroke and HBP, alcohol consumption, active smoking, sedentary lifestyle, BMI and survey year were associated with adherence to cervical cancer screening.

3.4. Comparison of Adherence Rates to FOBT between Individuals with and without Diabetes according to Sociodemographic, Health and Lifestyle Variables

Table 4 presents the comparison of characteristics among participants aged over 50 years who reported undergoing FOBT based on the positive or negative diagnosis of DM. Significant differences in adherence between populations with and without diabetes were observed concerning only education level, showing a higher adherence percentage among individuals with diabetes with a lower education level compared to those without diabetes (19.0% vs. 9.6%, $p = 0.017$).

Table 4. Prevalence of Spain's resident population with and without diabetes who underwent screening for colorectal cancer according to sociodemographic, clinical and lifestyle features.

Variables	Categories	FOBT Last 2 Years						
		No Diabetes		Diabetes		Both		*p*-Value
		n	%	n	%	n	%	
Gender	Male	212	23.9	220	24.8	432	24.4	0.658
	Female	139	21.2	148	22.6	287	21.9	0.548
Age groups (years old) [A,C]	50–59	103	18.6	121	21.8	224	20.2	0.178
	60–69	248	25.1	247	25.0	495	25.1	0.959

Table 4. *Cont.*

Variables	Categories	FOBT Last 2 Years						
		No Diabetes		Diabetes		Both		*p*-Value
		n	%	n	%	n	%	
Education level [A,C]	No studies/primary	13	9.6	41	19.0	54	15.3	0.017
	Secondary	271	23.9	289	25.0	560	24.5	0.524
	High education	67	24.7	38	22.2	105	23.8	0.547
Living with a partner [B,C]	No	233	24.1	260	25.8	493	25.0	0.914
	Yes	117	20.5	108	20.3	225	20.4	0.376
Self-rated health	Fair/poor/very poor	233	22.6	153	23.4	386	22.9	0.642
	Very good/good	118	23.1	215	24.2	333	23.8	0.710
COPD	No	322	22.7	319	23.7	641	23.2	0.517
	Yes	29	23.8	49	24.9	78	24.5	0.824
Cardiac ischemia	No	332	22.4	333	23.8	665	23.1	0.378
	Yes	19	31.7	35	24.6	54	26.7	0.303
Stroke [A]	No	344	22.7	350	23.7	694	23.2	0.534
	Yes	7	24.1	18	27.7	25	26.6	0.719
Cancer [A,C]	No	319	22.1	329	23.1	648	22.6	0.504
	Yes	32	32.7	39	32.5	71	32.6	0.981
Mental disease	No	299	22.5	283	23.4	582	22.9	0.600
	Yes	52	24.2	85	25.5	137	25.0	0.724
High blood pressure	No	234	22.4	150	23.8	384	22.9	0.522
	Yes	117	23.5	218	23.9	335	23.8	0.854
Alcohol consumption	No	125	20.4	182	22.5	307	21.6	0.333
	Yes	226	24.4	186	25.4	412	24.8	0.621
Active smoking [A,C]	No	281	24.2	282	23.9	563	24.0	0.863
	Yes	69	18.2	86	23.8	155	20.9	0.061
Sedentary lifestyle [A,B,C]	No	251	24.5	229	25.7	480	25.1	0.540
	Yes	100	19.3	139	21.3	239	20.4	0.396
Body mass index (kg/m^2)	<25	127	23.6	84	27.8	211	25.1	0.177
	25–29.9	152	23.1	147	23.5	299	23.3	0.847
	≥30	60	20.9	129	23.0	189	22.3	0.489
EHISS [A,B,C]	2014	100	13.0	106	13.8	206	13.4	0.653
	2020	251	32.4	262	33.8	513	33.1	0.553

[A]: Significant association for population without diabetes; [B]: Significant association for population with diabetes; [C]: Significant association for both. *p*-value represents comparison of frequencies between non-diabetes and diabetes populations.

Variables such as age, education level, diagnosis of stroke or cancer, alcohol consumption, active smoking, sedentary lifestyle and survey year were associated with FOBT adherence in the population without diabetes, whereas variables such as living with a partner, sedentary lifestyle and survey year were significantly associated with undergoing FOBT in the population with diabetes. For the total population, age, education level, living with a partner, cancer diagnosis, sedentary lifestyle and survey year were associated with adherence to CRC screening.

3.5. Predictors of Adherence to Breast Cancer Screening Programme Based on Diabetes Diagnosis

Table 5 displays the predictors of adherence to mammography among female participants based on the presence or absence of diabetes and in the total study population. In women without diabetes, age over 50 years, living with a partner and alcohol consumption

were significantly associated with better adherence to mammography. In women with diabetes, age over 50 years and a history of cancer were associated with higher adherence to this diagnostic test. In the total participant cohort, age over 50 years, living with a partner and cancer diagnosis were associated with better adherence to mammography. Conversely, the presence of DM was associated with lower adherence to this screening procedure.

Table 5. Predictors of adherence to mammography screening in women participating in the European Health Interview Surveys (2014 and 2020) in Spain, according to the presence of diabetes.

Variables	Categories	No Diabetes OR (95% CI)	Diabetes OR (95% CI)	Both OR (95% CI)
Age groups (years old)	40–49	1	1	1
	50–59	4.85 (2.81–8.38)	5.26 (3.06–9.04)	4.88 (3.33–7.15)
	60–69	3.46 (2.12–5.64)	4.08 (2.45–6.80)	3.56 (2.50–5.06)
Living with a partner	No	1	-	1
	Yes	13.24 (1.33–132.01)	-	15.81 (1.73–144.25)
Cancer	No	-	1	1
	Yes	-	2.88 (1.38–6.01)	2.31 (1.38–3.86)
High blood pressure	No	-	1	1
	Yes	-	NS	NS
Alcohol consumption	No	1	-	-
	Yes	1.54 (1.10–2.18)	-	-
Diabetes	No	-	-	1
	Yes	-	-	0.75 (0.59–0.96)
EHISS	2014	1	1	1
	2020	NS	NS	NS

3.6. Predictors of Adherence to Cervical Cancer Screening Programmes Based on Diabetes Diagnosis

Table 6 presents the predictors of Pap smear adherence among female participants based on the presence or absence of diabetes and in both populations. In participants without diabetes, only having a secondary or higher education level was associated with better Pap smear adherence. In participants with diabetes, both having a secondary or higher education level and participating in the 2020 EHISS were associated with higher Pap smear adherence. In the overall female participant cohort, the same associations as in participants with diabetes were observed. However, a sedentary lifestyle was identified as a predictor of poorer adherence to undergoing this screening test. Diabetes was not associated with adherence after multivariable adjustment.

Table 6. Predictors of adherence to Pap smear screening in women participating in the European Health Interview Surveys (2014 and 2020) in Spain, according to the presence of diabetes.

Variables	Categories	No Diabetes OR (95% CI)	Diabetes OR (95% CI)	Both OR (95% CI)
Age groups (years old)	18–39	1	1	1
	40–49	NS	NS	NS
	50–59	NS	NS	NS
	60–69	NS	NS	0.53 (0.34–0.83)
Education level	No studies/primary	1	1	1
	Secondary	3.27 (1.85–5.77)	1.55 (1.03–2.31)	2.00 (1.44–2.77)
	High education	4.99 (2.53–9.84)	2.26 (1.23–4.15)	3.20 (1.95–4.68)

Table 6. *Cont.*

Variables	Categories	No Diabetes OR (95% CI)	Diabetes OR (95% CI)	Both OR (95% CI)
Self-rated health	Fair/poor/ very poor	NS	-	NS
	Very good/good	1	-	1
Living with a partner	No	-	1	1
	Yes	-	NS	NS
Cardiac ischemia	No	1	-	1
	Yes	NS	-	NS
Stroke	No	1	-	1
	Yes	NS	-	NS
High blood pressure	No	-	1	1
	Yes	-	NS	NS
Alcohol consumption	No	1	-	1
	Yes	NS	-	NS
Active smoking	No	-	-	1
	Yes	-	-	NS
Sedentary lifestyle	No	1	1	1
	Yes	NS	NS	0.79 (0.66–0.95)
Body mass index (kg/m^2)	<25	1	1	1
	25–29.9	NS	NS	NS
	≥30	NS	NS	NS
Diabetes	No	-	-	1
	Yes	-	-	NS
EHISS	2014	1	1	1
	2020	NS	1.39 (1.03–1.86)	1.28 (1.04–1.58)

3.7. Predictors of Adherence to CRC Screening Programme Based on Diabetes Diagnosis

Table 7 compiles the predictors of adherence to FOBT among participants aged over 50 years based on the presence or absence of diabetes and in both populations. In individuals without diabetes, age over 60 years, secondary or higher education level, a history of cancer and participation in the 2020 EHISS group were predictors of better adherence to FOBT. However, a sedentary lifestyle was identified as a predictor of poorer adherence to this diagnostic test. In individuals with diabetes, only participation in the 2020 EHISS was a predictor of better adherence to FOBT. In the total participant cohort aged over 50 years, age over 60 years, secondary education level, a history of cancer and participation in the 2020 EHISS were associated with better adherence to FOBT. However, a sedentary lifestyle was associated with poorer adherence to undergoing this screening test.

Table 7. Predictors of adherence to FBOT screening in women participating in the European Health Interview Surveys (2014 and 2020) in Spain, according to the presence of diabetes.

Variables	Categories	No Diabetes OR (95% CI)	Diabetes OR (95% CI)	Both OR (95% CI)
Gender	Male	1	1	1
	Female	NS	NS	NS
Age groups (years old)	18–39	-	-	-
	40–49	-	-	-
	50–59	1	1	1
	60–69	1.43 (1.09–1.87)	NS	1.31 (1.08–1.58)

Table 7. *Cont.*

Variables	Categories	No Diabetes OR (95% CI)	Diabetes OR (95% CI)	Both OR (95% CI)
Education level	No studies/primary	1	-	1
	Secondary	2.69 (1.47–4.92)	-	1.62 (1.18–2.22)
	High education	2.49 (1.29–4.80)	-	NS
Living with a partner	No	-	1	1
	Yes	-	NS	NS
Stroke	No	1	-	-
	Yes	NS	-	-
Cancer	No	1	-	1
	Yes	1.80 (1.13–2.86)	-	1.74 (1.27–2.38)
Active smoking	No	1	-	1
	Yes	NS	-	NS
Sedentary lifestyle	No	1	1	1
	Yes	0.75 (0.57–0.99)	NS	0.79 (0.66–0.95)
Diabetes	No	-	-	1
	Yes	-	-	NS
EHISS	2014	1	1	1
	2020	3.29 (2.52–4.28)	3.23 (2.50–4.17)	3.24 (2.70–3.90)

4. Discussion

We analysed the temporal trend of adherence rates to breast, cervical and CRC screening programmes among individuals with diabetes residing in Spain, based on data from the EHISS surveys conducted in 2014 and 2020. The results revealed lower adherence to the studied oncological screening programmes among the population with diabetes compared to those without diabetes, with a significant increase in adherence to preventive Pap smear and FOBT tests among patients with diabetes from 2014 to 2020.

The results regarding adherence to preventive cervical cancer screening showed a 9% significant increase from 52.0% in 2014 to 61.0% in 2020 among women with diabetes aged 18 to 69 years. Additionally, adherence to FOBT rose by 20% in 2020 compared to 2014 among the population with diabetes. This increase suggests a shift in trend regarding adherence to cervical and CRC screening programmes compared to previous years. Previous studies have reported stable and lower adherence levels over time among the Spanish population with diabetes for both screening programmes [14,16]. Concerning mammography, the findings did not show significant differences between 2014 and 2020 among women with diabetes. However, notably, our study found a significant decrease in adherence to gynaecological screening programmes among individuals with diabetes compared to those without diabetes. Previous studies have also shown lower adherence to breast and cervical cancer screening programmes among individuals with diabetes compared to those without diabetes [14,17–21]. Similarly, prior studies have identified reduced adherence to FOBT among the population with diabetes compared to those without diabetes [17–19]. However, our study did not observe this difference, consistent with another prior study conducted in Spain [16].

A possible reason for the lower adherence to oncological screening programmes among people with diabetes could be that disease control might compete with preventive care, with patients focusing on clinical diabetes control and perceiving long-term disease prevention as less important, even though they may be related to diabetes [22,23]. Different studies have described that physicians and patients tend to prioritise demands and only deal with the most pressing or symptomatic problems, leading to clinical inertia [14,20].

Among the adults with diabetes in our study, several factors associated with higher adherence to the oncological screenings analysed were found in both populations, with

and without diabetes. Age was identified as a predictor of mammography in both groups, with and without diabetes. Consistent with other studies, adherence to mammography increased with age up to 69 years [24–26]. Additionally, living with a partner was a positive factor for mammography adherence in women without diabetes. This finding coincides with previous studies, suggesting that women living with a partner may be more motivated by their family members to undergo preventive tests [24,25].

Surprisingly, moderate alcohol consumption was associated with higher adherence to breast cancer screening. This result may seem controversial; however, in Spain, moderate alcohol consumption is common among women of higher socioeconomic status, and higher socioeconomic status is associated with greater acceptance of cancer screening tests. Regarding women with diabetes, the only factor in addition to age that seemed to affect adherence to mammography was, interestingly, cancer diagnosis. Previous studies have also established a positive relationship between higher comorbidity and adherence to breast cancer screening in women with diabetes [16].

In previous studies, more mammograms were performed in the population with diabetes [27]. However, in our study, the presence of diabetes was identified as a predictor of poorer adherence to mammography, as previously described in a study conducted in Spain in 2009 [20]. Understanding the factors influencing adherence to mammography in patients with diabetes is important because this population has a higher risk of breast cancer [28] and a higher risk of mortality exists in women with diabetes with breast cancer compared to those without diabetes [29].

As expected, a higher level of education was positively associated with adherence to cervical cancer screening in both populations, with and without diabetes. This finding is consistent with other studies [30]. Higher education level and socioeconomic status have been associated with greater use of preventive services and cancer screening rates, especially in the case of cervical cancer, whose screening is based on an opportunistic system [25]. In the group of women with diabetes, the survey edition was identified as a positive predictor, suggesting that, albeit insufficiently, women with diabetes seemed to progressively adhere to Pap smears.

In both groups, with and without diabetes, education level was a predictor of CRC screening adherence. Among the analysed parameters, age, education level, cancer diagnosis and sedentary lifestyle were predictors of adherence to CRC screening in individuals without diabetes. In line with the programmes previously described, a previous diagnosis of cancer and a sense of greater vulnerability to CRC risk could explain higher adherence in subjects aged 60–69 years [31,32]. Regarding the finding that a higher education level was associated with greater adherence in people without diabetes, other authors have reported similar results [33,34], suggesting that knowing the signs or symptoms of CRC is associated with the use of procedures for this type of cancer and staying current with screening [35,36]. Interestingly, healthy behaviours such as an active lifestyle may reflect individual perceptions of the importance of overall good health, prevention of health risks and perceived risk [37,38]. This reasoning could explain our results regarding the negative association of sedentary behaviour with CRC screening. Finally, in both groups, with and without diabetes, the edition of EHISS was a predictor. The progressive improvement in adherence levels to FOBT over time seems to reflect its gradual implementation since 2000 in Spain, with the programme being introduced at different times in each region [9]. In this sense, our group previously identified that the different periods of CRC screening implementation constituted a crucial factor in improving adherence to CRC screening from 2011 to 2017 in the resident population in Spain [39].

Obesity, a large number of chronic diseases and even mental disorders are highly prevalent in the population with diabetes. Interestingly, previous studies have reported that obesity and mental disorders may contribute to the decreased uptake described in the population with diabetes in the present study. Indeed, patients with obesity may face physician bias, which may in turn lead to poor patient–physician relationships and communication and lower rates of screening [40,41]. Furthermore, patients' self-perceptions of

negative body image may affect preferences for screening; factors such as embarrassment and even unwanted advice to lose weight may be considered barriers that affect participation [42]. Conversely, it has been suggested that own hospital attendance due to diabetes or concomitant chronic diseases may be a potential barrier to preventive care. In this regard, providing guideline-adherent chronic disease care also requires more consultation time than physicians have available per patient [43–46], which may lead to the prioritisation of diabetes-related care over routine preventive care [45–47].

As a reflection of these results, a need exists for educational programmes targeting the population with diabetes and healthcare professionals to raise awareness of the importance of undergoing the described preventive services. We propose that primary care professionals actively engage in querying patients with diabetes about their participation in screening tests and provide reminders to those who have not yet completed such assessments. Additionally, interventions that allow increasing acceptance of screening should be studied and implemented, including electronic reminders and active recruitment strategies, such as follow-up phone calls or a second invitation letter.

With the aim of increasing adherence to oncologic screening programs in the population with diabetes, it is also important to point out that shared care between primary care physicians and diabetes specialists has been associated with better adherence to diabetes-related health services and a higher likelihood of receiving breast and cervical cancer screening compared with care by either practitioner alone [48]. Accordingly, this suggests that integrated diabetes management models may therefore improve attention to other recommended preventive health services by offloading diabetes care from primary care physicians. Supporting diabetes self-management as well as emphasising the importance of preventive care in the diabetic population through training courses or communication media may also better screening participation.

Our study has significant strengths. Firstly, the large sample size provides high power to detect small significant statistical differences. Secondly, it included a control group for a more rigorous study. Thirdly, being a nationally representative survey, the sample is representative of the Spanish population. Fourthly, the methodological rigour of the EHISS ensures the validity of the study and allows for the comparison of these data in future studies with the next editions of the same survey. However, our study also has limitations. The most important is that it did not distinguish between type 1 and type 2 diabetes. The pathophysiology of the two types of diabetes is different, so the result obtained jointly may not be fully applicable when dealing with one of the two specific types. Similarly, the survey does not specify the level of diabetes control, or the treatments employed, factors that could influence both quality of life and adherence to screening tests. The data obtained in the surveys also correspond to information reported by the participants and thus may not fully correspond to their clinical situation due to memory biases or socially conditioned responses, which could influence the results and affect the validity of the study. In addition, although most participants completed the survey in person, a portion of the 2020 survey was conducted by telephone due to the COVID-19 pandemic, and the survey did not distinguish the method of contact with the participant. This fact may lead to certain biases derived from this difference. Due to the large sample size and the high number of comparisons made, the type I error may not be negligible. Therefore, caution must be exercised when interpreting the results of this study. Additionally, despite identifying several predictor factors associated with adherence to screening tests, given that this is an observational study, there is a need for caution in interpreting these associations as causal. Finally, due to the standard methodology used for conducting the surveys, there is a lack of relevant data for analysing adherence to screening tests, such as diet, socioeconomic level and psychological barriers.

5. Conclusions

The adherence levels to the oncological screening systems implemented in Spain were significantly lower in the population with diabetes compared to the population without

diabetes. However, an improvement in Pap smear and FOBT adherence was observed in the 2020 survey compared to the 2014 survey among the population with diabetes, although the figures were still far from desirable adherence levels. A better understanding of adherence predictors is important to improve the rate of screening tests in patients with diabetes, given their higher risk of developing these types of cancer, their lower adherence to the screening tests and their worse prognosis.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/jcm13113047/s1, Table S1: Definition of variables according to the questions included in the European Health Interview Surveys in Spain conducted in the years 2014 and 2020.

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8.2. Artículo 2

"Association Between Physical Activity and Adherence to Nutritional Recommendations in Individuals with Diabetes: Analysis of Self-Reported Data from the 2020 European Health Survey in Spain"

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Association Between Physical Activity and Adherence to Nutritional Recommendations in Individuals with Diabetes: Analysis of Self-Reported Data from the 2020 European Health Survey in Spain

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Abstract: Background/Objectives: This study compares dietary and physical activity (PA) habits between Spanish adults with and without diabetes and analyzes the association between PA, sociodemographic variables, and adherence to nutritional recommendations among individuals with diabetes. **Methods:** A cross-sectional case–control study was conducted using data from the 2020 European Health Survey for Spain (EESE). Diabetes and PA levels were self-reported. Each participant with diabetes was matched with a control without diabetes by age, gender, and region of residence. Food intake was assessed using a food frequency questionnaire, and adherence to nutritional guidelines was evaluated based on the recommendations of the Spanish Agency for Food Safety and Nutrition. The PA levels were classified as "sedentary/low" or "moderate/high". **Results:** A total of 2053 matched pairs were analyzed. The participants with diabetes adhered to significantly more nutritional recommendations than those without diabetes (6.19 vs. 5.30; $p < 0.001$). However, 88.6% of the individuals with diabetes reported sedentary or low PA levels. Among those with diabetes, women showed better adherence to nutritional recommendations, while men reported higher PA levels. Moderate/high PA was associated with greater adherence to nutritional recommendations (OR 1.991; 95% CI: 1.201–3.146). Older age was also positively associated with adherence. **Conclusions:** Although individuals with diabetes demonstrated better adherence to nutritional recommendations than controls, most reported low PA levels. Higher PA levels, female gender, and older age were linked to greater adherence to nutritional recommendations among people with diabetes. However, the use of self-reported data made it impossible to judge whether the participants under- or over-reported their PA levels and diabetes status. Public health strategies should aim to promote both PA and healthy eating habits in this population.

Keywords: diabetes; nutrition; physical activity; gender; adherence; lifestyles

1. Introduction

Diabetes is a chronic condition with great impact on the quality of life of millions of people and impose a substantial socioeconomic burden [1]. Diabetes prevalence continues to rise, currently affecting nearly 537 million adults worldwide [1]. In Spain, the prevalence reaches 14.8% in the adult population, affecting approximately 5.1 million adults, with a significant proportion of undiagnosed cases [1]. According to the di@bet.es study, the national cumulative incidence of these condition was 6.4% over 7.5 years of follow-up among adults, increasing with age and being higher in males [2].

Managing diabetes requires a multifactorial approach aimed at achieving glycemic control and reducing cardiovascular risk [3]. Among the most cost-effective strategies are therapeutic adherence, appropriate nutritional guidelines, physical activity (PA), and smoking cessation [4].

PA plays a fundamental role in both prevention and management of diabetes, as it improves insulin sensitivity, reduces HbA1c levels, contributes to weight control, and lowers overall cardiovascular risk [5]. However, the PA levels tend to be lower among adults with diabetes compared to the general population. Although there has been a favorable trend in PA engagement over time, a high prevalence of sedentary behavior persists [6]. The sociodemographic and clinical factors associated with lower PA levels among people with diabetes include gender, age, lower educational level, smoking, chronic conditions such as obesity, mental health disorders, and self-perceived health [6].

Diet is equally crucial in diabetes management [7]. The promotion of the "diabetes plate" method is recommended to ensure a nutritious, balanced diet with moderate calorie intake, often stricter than for the general population [8,9]. A personalized dietary plan, with specific recommendations for carbohydrate intake tailored particularly to the PA levels, is encouraged. When coordinated with medication, this approach—referred to as "medical nutritional therapy"—aims to maintain stable blood glucose levels, prevent hypoglycemia, and reduce long-term complications. Additionally, adherence to dietary guidelines contributes to a reduction in cardiovascular comorbidities by decreasing saturated fat and salt intake, thus preventing dyslipidemia and hypertension [7]. Various dietary patterns have demonstrated benefits in metabolic disease management, notably, the Mediterranean diet (MD), which significantly reduces chronic low-grade inflammation and improves insulin sensitivity [10–12].

The MD has been designated as an intangible cultural heritage with particular lifestyle and eating habits typical of the Mediterranean Sea region [12–14]. The MD is not just a model of cultural food choices, cooking methods, meal patterns, or lifestyle. Several other factors contribute to the MD, such as the selection and preference of a wide variety of traditional and local foods sustained by the local culinary heritage, the use of indigenous ingredients, and thus the production (plants and animal) and capture (e.g., fish, wild rabbit, fowl) of foods that are locally frequent. In the MD, a moderate consumption of wine is also culturally accepted, preferably during a meal. In Spain and other Mediterranean countries, mealtimes have a social and cultural value that transcends their nutritional and nourishing functions. Spain is a major producer and exporter of typical Mediterranean products [13,14].

The MD dietary pattern is characterized by the preferred use of olive oil; a rich intake of plant-based foods; a preference for white lean meat; and a moderate consumption of fish, whole-grain cereals, and red wine [12–15]. This is additionally balanced by a reduced

intake of sugar-sweetened drinks, red and processed meats, whole-fat dairy products, and industrial desserts [12–15]. However, adherence to this traditional pattern appears to be declining, especially among younger generations, due to the Westernization of diets and the spread of urban lifestyles [14,16]. This change is characterized by an increased consumption of refined cereals, red and processed meat, and beverages containing high levels of sugars [13–16].

In Spain, adherence to the MD among people with diabetes has been analyzed by different authors, who observed that only a small proportion of these patients have high adherence to the MD, with most patients reaching only a moderate level [17–22]. Factors like older age, female gender, high educational level, and living in southern regions were associated with a higher adherence to the MD [17–22].

Quarta et al. [15] compared the adherence patterns to the MD in Spain with those in four Mediterranean Southern European countries (Portugal, Italy, Greece, and Cyprus) and two non-Mediterranean European countries (Bulgaria and the Republic of North Macedonia) using the 14-item MD Adherence Screener scoring system. The sample population from Spain showed the highest adherence among all the participant countries [15]. The study groups participating in the European Prospective Investigation into Cancer and Nutrition showed only small differences in the consumption of vegetables, fish, and meat, with slightly higher consumption by individuals with diabetes compared to those without. Among those with diabetes, the findings were more consistent across different ethnic groups than across different countries but generally showed largely similar patterns [23].

Other studies across Europe also suggest that individuals with diabetes in Mediterranean countries, such as Spain or Italy, tend to report higher adherence to healthy dietary patterns, particularly the MD, than those in Northern European countries [24–27].

To date, national studies have reported varying degrees of adherence to nutritional recommendations among individuals with diabetes, generally demonstrating greater adherence compared to the general population. However, the results concerning associations with variables such as age, gender, and PA are scarce or have not been consistent [17–22].

The objectives of this study, based on data from the 2020 European Health Survey for Spain (EESE), are the following: (i) to describe and compare dietary habits and PA levels among Spanish adults with and without diabetes matched by age and gender; (ii) to analyze the association of PA and sociodemographic variables with adherence to nutritional recommendations in individuals with diabetes.

2. Materials and Methods

A cross-sectional, case–control study design was employed, matching individuals with and without diabetes by age, sex, and region of residence and improving study efficiency and precision [28].

The data source was the latest EESE conducted in 2020 [29,30]. This survey used a three-stage sampling method to obtain a nationally representative sample of non-institutionalized individuals aged ≥15 years [29]. The participants were personally interviewed at home. The EESE 2020 was conducted between July 2019 and July 2020. Due to the COVID-19 pandemic, telephone interviews were conducted from March to July 2020 [29].

The study population included all interviewed adults (≥18 years). The participants were classified as having diabetes if they answered affirmatively to the question: "*Have you been diagnosed with diabetes by a physician*?" Participants answering "no" were classified as not having this condition.

For each participant with diabetes(case), a control without diabetes, matched by identical age, gender, and region of residence, was randomly selected. If more than one control was available, the selection was made randomly.

2.1. Study Variables

The "PA Frequency" variable was created using the EESE question: "*What type of PA do you engage in during your free time?*", with four possible responses: 1. I do not exercise. My leisure time is primarily sedentary; 2. I engage in occasional physical or sports activities (e.g., walking, cycling, gardening, light gymnastics, recreational activities requiring minimal effort, etc.); 3. I participate in physical activities several times a month (e.g., sports, gymnastics, running, swimming, cycling, team games, etc.); 4. I undergo athletic or physical training multiple times a week. Responses 1 and 2 were categorized as "sedentary or low PA", and responses 3 and 4 as "moderate or high PA. We joined responses 1 and 2 because, in our opinion, these two options possibly included mostly sedentary individuals. This is so because, in Spanish, "occasional" is a synonym for "sporadic", "circumstantial", "fortuitous", "punctual". On the other hand, we joined responses 3 and 4 due to the small numbers in these categories among the participants with diabetes (corresponding to 4.7% and 6.7%, respectively) and to the fact that, in our opinion, these adults were clearly not sedentary and performed some regular PA.

The EESE 2020 food frequency questionnaire was utilized [29]. The frequency of consumption of nine food groups was analyzed, including fruits and vegetables; meat; eggs; fish; legumes; pasta, rice, and potatoes; bread and cereals; dairy products; and sugary soft drinks. The *"recommended intakes"* for each food group were those published in the year 2022 by the Agencia Española de Seguridad Alimentaria y Nutrición (Spanish Agency for Food Safety and Nutrition) in the document titled "Informe del Comité Científico de la Agencia Española de Seguridad Alimentaria y Nutrición (AESAN) sobre recomendaciones dietéticas sostenibles y recomendaciones de actividad física para la población Española" ("Report of the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) on sustainable dietary recommendations and PA recommendations for the Spanish population"). The details are available elsewhere [31]. Table S1 details the EESE 2020 questions, responses, and categorization criteria used in creating the variables for this study. Additionally, the total number (0–9) of recommendations met was calculated, and the proportion of cases and controls meeting five or more recommendations was analyzed.

The covariates included gender (male/female), age groups (18–49, 50–69, $\geq$70 years), educational level (no studies/primary, secondary, high education), and living with a partner (see Table S1).

2.2. Statistical Analysis

A descriptive analysis was performed using absolute numbers and percentages for the qualitative variables and means with standard deviations for the quantitative variables. Analytical statistics included chi-squared test with Fisher correction, Student's *t*-test, Mann–Whitney test, ANOVA, or Kruskal–Wallis test, as appropriate. A two-sided *p*-value of <0.05 was considered significant. The Bonferroni–Holm method was applied to adjust the *p* values for multiple testing when required.

Three multivariable logistic regression models (diabetes group, non-diabetes control group, and total population) were constructed, with adherence to more than half of the nutritional recommendations as the dependent variable. The independent variables included gender, age, education level, living with a partner, and diabetes status in the last model. The associations were quantified using the odds ratios (OR) with 95% confidence intervals (95% CI). The analyses were conducted using SPSS v29.

2.3. Ethical Considerations

An anonymized EESE dataset is freely accessible via the National Statistics Institute's website [32]. According to the Spanish legislation, ethics committee approval was not required for this research.

3. Results

3.1. Description of the Study Population

A total of 2150 participants aged 18 years or older with self-reported diabetes were identified in the EESE 2020. After excluding those with missing data, 2053 subjects with diabetes remained, each one matched with a control without the condition, resulting in a total study population of 4106 individuals (Table 1). Females constituted 50.3% of the sample, and the mean age was 69.60 years (SD 12.89).

Table 1. Distribution of participants with diabetes and matched controls without diabetes according to socio-demographic variables, physical activity level, and adherence to recommended consumption of food groups.

Variables	Categories	No Diabetes		Diabetes		*p*
		N	%	N	%	
Gender	Male	1020	49.7	1020	49.7	NA
	Female	1033	50.3	1033	50.3	
Age groups	18 to 49 years	136	6.6	136	6.6	NA
	50 to 69 years	775	37.8	775	37.8	
	70 or older	1138	55.5	1138	55.5	
Age (mean) [SD]		(69.60)	[12.89]	(69.60)	[12.89]	NA
Living with a partner	Yes	1081	53.0	1065	52.1%	0.573
Educational level	No studies/primary	1360	66.2	1549	75.5%	<0.001
	Secondary	291	14.2	239	11.6%	
	High education	402	19.6	265	12.9%	
Physical activity frequency	Sedentary/low	1695	82.6	1819	88.6%	<0.001
	Moderate/high	358	17.4	234	11.4%	
Adherence to recommended consumption of fruits and vegetables		1635	79.7	1657	80.7	0.433
Adherence to recommended consumption of meat		1609	78.6	1605	78.2	0.790
Adherence to recommended consumption of eggs		1849	90.2	1895	92.3	0.017
Adherence to recommended consumption of fish		979	47.8	928	45.2	0.104
Adherence to recommended consumption of pasta, rice, and potatoes		1706	83.3	1700	82.8	0.739
Adherence to recommended consumption of bread and cereals		124	6.1	140	6.8	0.340
Adherence to recommended consumption of legumes		134	6.5	136	6.6	0.950
Adherence to recommended consumption of dairy products		1732	84.5	1747	85.1	0.602
Adherence to recommended consumption of sugary soft drinks		1259	61.5	1584	77.2	<0.001
Number of nutritional recommendations achieved (mean) [SD]		(5.30)	[1.2]	(6.19)	[1.34]	<0.001
Five or more nutritional recommendations achieved		1569	76.9	1852	90.6	<0.001

NA: not applicable; SD: standard deviation. *p* values for differences between participants with diabetes and matched controls without diabetes.

3.2. Comparison Between Individuals with and Without Diabetes

Table 1 shows the distribution of the participants with and without diabetes, matched by age and gender, according to the study variables. Those with diabetes had significantly lower educational levels and significantly higher sedentary or low PA levels (88.6% vs. 82.6% in the control group; $p < 0.001$).

The adherence to nutritional recommendations was above 75% for all food groups except for fish (45.2%), pasta, rice, and potatoes (6.6%), and legumes (6.6%). The individuals with diabetes showed significantly higher adherence than the control group for the consumption of eggs (92.3% vs. 90.2%) and sugary soft drinks (77.2% vs. 61.5%).

The mean number of nutritional recommendations fulfilled was significantly higher among those with diabetes compared to the control group (6.19 vs. 5.30; $p < 0.001$). More than 90% of the individuals with diabetes met more than half of the total nutritional recommendations, compared to 76.91% in the control group ($p < 0.001$).

3.3. Analysis of Adherence to Nutritional Recommendations by Gender

As can be seen in Table 2, males with diabetes exhibited significantly higher adherence to the recommendations than males in the control group for the consumption of eggs (92.6% vs. 89.9%; $p = 0.028$) and sugary soft drinks (77.3% vs. 57.3%; $p < 0.001$).

Among females with diabetes, adherence to sugary soft drink consumption recommendations was significantly higher compared to that of their counterparts in the control group (77.1% vs. 65.3%; $p < 0.001$), though their adherence to the recommended fish consumption was lower (44% vs. 50.4%; $p = 0.004$).

Females with diabetes had higher adherence to the fruit and vegetable, meat, and dairy recommendations, but lower adherence to the recommendations for bread and cereals compared to males with diabetes. The mean number of recommendations met and the proportion of participants meeting more than half of the recommendations were significantly higher among females compared to males with diabetes (Table 2).

Table 2. Distribution of participants with diabetes and matched controls without diabetes by sociodemographic variables, physical activity levels, and adherence to recommended consumption of food groups according to gender.

		Male					Female				
Variables	**Categories**	**No Diabetes**		**Diabetes**		***p***	**No Diabetes**		**Diabetes**		***p***
		N	**%**	**N**	**%**	**%**	**N**	**%**	**N**	**%**	
Age groups *	18 to 49 years	74	7.3	74	7.3	NA	62	6.0	62	6.0	NA
	50 to 69 years	447	44.0	447	44.0		328	31.8	328	31.8	
	70 or older	496	48.8	496	48.8		642	62.2	642	62.2	
Age (mean) [SD] *		(67.84)	[12.43]	(67.84)	[12.43]	NA	(71.35)	[13.10]	(71.35)	[13.10]	NA
Living with a partner *	Yes	641	63.3	643	63.2	0.981	440	42.8	422	41.1	0.410
Educational level *	No studies/primary	622	61.0	714	70.0	<0.001	738	71.4	835	80.8	<0.001
	Secondary	157	15.4	145	14.2		134	13.0	94	9.1	
	High education	241	23.6	161	15.8		161	15.6	104	10.1	
Physical activity frequency *	Sedentary/low	822	80.6	885	86.8	<0.001	873	84.5	934	90.4	<0.001
	Moderate/high	198	19.4	135	13.2		160	15.5	99	9.6	

Table 2. *Cont.*

Variables	Categories	Male					Female				
		No Diabetes		Diabetes		*p*	No Diabetes		Diabetes		*p*
		N	%	N	%	%	N	%	N	%	
Adherence to recommended consumption of fruits and vegetables *		771	75.7	804	78.8	0.091	864	83.7	853	82.6	0.518
Adherence to recommended consumption of meat		774	76.2	778	76.3	0. 958	835	81.0	827	80.1	0.617
Adherence to recommended consumption of eggs		915	89.9	944	92.6	0.028	934	90.6	951	92.1	0.242
Adherence to recommended consumption of fish		459	45.1	473	46.4	0.564	520	50.4	455	44.0	0.004
Adherence to recommended consumption of pasta, rice, and potatoes		86	8.5	69	6.8	0.156	48	4.7	67	6.5	0.084
Adherence to recommended consumption of bread and cereals *		875	86.0	874	85.7	0.849	831	80.5	826	80.0	0.825
Adherence to recommended consumption of legumes		60	5.9	69	6.8	0.467	64	6.2	71	6.9	0.593
Adherence to recommended consumption of dairy products *		838	82.4	847	83.1	0.682	894	86.6	900	87.1	0.745
Adherence to recommended consumption of sugary soft drinks		585	57.6	788	77.3	<0.001	674	65.3	796	77.1	<0.001
Number of nutritional recommendations achieved (mean) [SD] *		5.29	1.33	6.16	1.36	<0.001	5.53	1.22	6.44	1.33	<0.001
Five or more nutritional recommendations achieved *		765	73.4	896	87.8	<0.001	804	83.2	956	92.4	<0.001

NA: not applicable; SD: standard deviation. *p* values for differences between participants with diabetes and matched controls without diabetes. * Means significant differences ($p < 0.05$) between males and females with diabetes.

3.4. Physical Activity Frequency and Adherence to Nutritional Recommendations

Tables 3 and 4 compare the demographic variables and food consumption by the PA levels across the study groups. Among those with diabetes, individuals with moderate or high PA levels had significantly greater adherence to the dietary recommendations for fruits and vegetables, dairy products, and sugary soft drinks. They also met a significantly higher mean number of recommendations and showed higher adherence rates for more than half of the recommendations.

Table 3. Distribution of participants with diabetes by socio-demographic variables and adherence to recommended consumption of food groups according to physical activity frequency.

Variable	Categories	Diabetes				
		Sedentary/Low		Moderate/High		*p*
		N	%	N	%	
Gender	Male	885	48.6	135	57.5	0.011
	Female	934	51.4	99	42.5	
Age groups	18 to 49 years	104	5.7	32	13.7	<0.001
	50 to 69 years	667	36.7	108	46.4	
	70 or older	1045	57.5	93	39.9	
Age (Mean) [SD]		70.46	12.42	63.84	13.22	<0.001
Living with a partner	No	882	48.6	98	41.8	0.057
	Yes	930	51.4	135	58.2	
Educational level	No studies/primary	1414	77.7%	135	57.5%	<0.001
	Secondary	198	10.9%	41	17.6%	
	High education	207	11.4%	58	24.9%	
Adherence to recommended consumption of fruits and vegetables		1526	79.9	210	86.4	0.016
Adherence to recommended consumption of meat		1507	78.9	186	76.5	0.406

Table 3. *Cont.*

Variable	Categories	Diabetes				
		Sedentary/Low		Moderate/High		*p*
		N	%	N	%	
Adherence to recommended consumption of eggs		1764	92.4	221	90.9	0.446
Adherence to recommended consumption of fish		861	45.1	111	45.7	0.891
Adherence to recommended consumption of pasta, rice, and potatoes		126	6.6	16	6.6	1.000
Adherence to recommended consumption of bread and cereals		1572	82.3	205	84.4	0.473
Adherence to recommended consumption of legumes		124	6.5	23	9.5	0.103
Adherence to recommended consumption of dairy products		1614	84.5	219	90.5	0.012
Adherence to recommended consumption of sugary soft drinks		1459	76.4	205	84.4	0.004
Number of nutritional recommendations achieved (mean) [SD]		5.85	1.35	6.48	1.22	<0.001
Five or more nutritional recommendations achieved		1573	86.48	227	97.01	<0.001

SD: standard deviation. *p* values for differences between participants with sedentary/low and participants with moderate/high physical activity levels.

Table 4. Distribution of matched controls without diabetes by socio-demographic variables and adherence to recommended consumption of food groups according to physical activity frequency.

Variable	Categories	No Diabetes				
		Sedentary/Low		Moderate/High		*p*
		N	%	N	%	
Gender	Male	822	48.5	198	55.2	0.019
	Female	873	51.5	160	44.8	
Age groups	18 to 49 years	92	5.4	44	12.4	<0.001
	50 to 69 years	609	36.0	166	46.8	
	70 or older	993	58.6	145	40.8	
Age (Mean) [SD]		70.75	12.58	64.73	11.99	<0.001
Living with a partner	No	82	47.6	157	43.6	0.226
	Yes	882	52.4	199	56.4	
Educational level	No studies/primary	1197	70.6	163	45.1	<0.001
	Secondary	219	12.9	72	20.3	
	High education	279	16.5	123	34.6	
Adherence to recommended consumption of fruits and vegetables		1338	79.0	297	83.7	0.047
Adherence to recommended consumption of meat		1337	79.2	272	76.1	0.188
Adherence to recommended consumption of eggs		1537	90.9	312	87.3	0.039
Adherence to recommended consumption of fish		806	47.7	173	48.5	0.795
Adherence to recommended consumption of pasta, rice, and potatoes		109	6.4	25	7.0	0.682
Adherence to recommended consumption of bread and cereals		1398	82.7	308	85.9	0.136
Adherence to recommended consumption of legumes		105	6.2	19	5.4	0.530
Adherence to recommended consumption of dairy products		1432	84.7	300	83.9	0.729
Adherence to recommended consumption of sugary soft drinks		1026	60.7	233	65.4	0.105
Number of nutritional recommendations achieved (mean) [SD]		5.19	1.279	5.45	1.33	0.424
Five or more nutritional recommendations achieved		1312	77.40	267	74.58	0.675

SD: standard deviation. *p* values for differences between participants with sedentary/low and participants with moderate/high physical activity levels.

However, adherence remained low for legumes (9.5%), pasta, rice, and potatoes (6.6%), and fish (45.7%), even among those with higher PA levels.

As can be seen in Table 4, among the matched controls without diabetes, those with sedentary/low PA levels had a significant higher adherence to dietary recommendations than those with moderate/high PA levels only for the consumption of eggs (90.9% vs. 87.3%; $p = 0.039$). Neither the mean number of nutritional recommendations nor the proportion of five or more nutritional recommendations achieved was associated with the level of PA among the participants without diabetes

3.5. Multivariable Analysis of Factors Associated with Higher Adherence to Nutritional Recommendations

Table S2 presents a bivariate analysis identifying the variables associated with fulfilling more than half of the nutritional recommendations by the study groups. The multivariable logistic regression results are presented in Table 5.

Table 5. Multivariable analysis with logistic regression to identify variables associated with having more than half of the nutritional recommendations met according to the diabetes status.

Variables	Categories	No Diabetes			Diabetes			All Participants		
		OR	CI95%		OR	CI95%		OR	CI95%	
			Inf	Sup		Inf	Sup		Inf	Sup
Gender	Male	Reference	-	-	Reference	-	-	Reference	-	-
	Female	1.540	1.227	1.933	1.342	1.128	1.590	1.425	1.256	1.657
Age groups	18 to 49 years	Reference	-	-	Reference	-	-	Reference	Reference	Reference
	50 to 69 years	2.356	1.595	3.479	1.635	1.061	2.569	1.911	1.287	2.606
	70 or older	3.259	2.101	5.902	1.852	1.468	6.013	2.480	1.627	3.833
Physical activity frequency	Sedentary/low	NS	NS	NS	Reference	-	-	Reference	-	-
	Moderate/high	NS	NS	NS	1.991	1.201	3.146	1.435	1.118	1.842
Diabetes	No	NA	NA	NA	NA	NA	NA	Reference	-	-
	Yes	NA	NA	NA	NA	NA	NA	1.692	1.427	2.006

CI: confidence interval. Inf; inferior. Sup; superior. OR: odds ratio. NS: not significant. NA: not applicable (variable not included in the model).

Older age and female gender were associated with higher adherence to the recommendations across all study groups; females with diabetes had an OR of 1.342 (95% CI: 1.128–1.590) compared to males.

Among those participants with diabetes, moderate to high PA levels were associated with better adherence to nutritional recommendations (OR 1.991; 95% CI: 1.201–3.146). Overall, diabetes was linked to significantly higher adherence to nutritional recommendations (OR 1.692; 95% CI: 1.427–2.006) after multivariable adjustment.

4. Discussion

The main findings of our research include the observation of greater adherence to nutritional recommendations among adults with diabetes compared to those without it, across both genders. Conversely, adherence to PA recommendations was lower among individuals with diabetes. Despite females with diabetes being older and having lower educational levels and a higher likelihood of living alone, this group demonstrated greater adherence to nutritional recommendations than their male counterparts. However, males exhibited higher adherence to the recommended PA levels. Among the participants with diabetes, higher PA levels were associated with healthier dietary habits compared with

lower PA levels. Age was also positively correlated with healthier dietary consumption in both study groups.

In developed countries, adherence to treatment in people with diabetes averages around 50% [33]. A person is considered adherent if they comply with 80–100% of the prescribed treatments, including medication, dietary recommendations, exercise, and self-management strategies [33,34]. Studies comparing dietary habits between individuals with diabetes and the general population have reported findings consistent with ours [17,18,20–23,35,36].

An Italian study by Tatoli et al., including 187 adults with diabetes and controls, reported greater dietary differences, with healthier choices for those with diabetes, whose dietary patterns were described as "vegetarian" [35].

These dietary differences have also been studied using healthy diet adherence indicators [37]. Huffman et al. [36] analyzed African American and Haitian American populations with and without diabetes, finding healthier dietary patterns for those with diabetes (N = 250) using the Alternative Healthy Eating Index, based on data from Harvard's food frequency questionnaire. Additionally, the dietary patterns were less favorable among African Americans compared to Haitian Americans, highlighting the importance of considering ethnicity in health studies [36].

However, a cross-sectional analysis of 111 Irish adults found significantly lower Mediterranean dietary pattern scores among individuals with diabetes compared to controls, measured by the MD Scale and the Alternative MD Scale [38]. In Spain, Vidal-Peracho et al., with a sample of 197 adults with diabetes and controls, reported higher adherence scores for the MD among those with diabetes [17]. Similarly, Alcubierre et al. reported healthier dietary patterns among 238 individuals with diabetes, using the Alternative MD Index and the Alternative Healthy Eating Index [18].

4.1. Gender-Specific Analysis

In our gender-specific analysis, females showed consistently higher dietary adherence than males in all population subgroups. Identifying improvement targets for females is particularly important, given that diabetes impacts males and females differently, disproportionately affecting female health across their lifespan [39–41].

A cross-sectional study of 2573 Italian adults with diabetes enrolled in the TOSCA.IT study identified gender differences in dietary choices, adherence to nutritional guidelines, and lipid profiles [24]. Further research by this group showed significantly higher MD adherence among females, older individuals, and residents of southern regions, though no associations were found with educational level, smoking, or marital status [25]. Zanetti et al., in a study involving 423 individuals with diabetes, reported higher dietary adherence among females, individuals with higher educational levels, and those with a lower socioeconomic status [26].

National studies, including those by Vidal-Peracho et al. and Alcubierre et al., have similarly reported healthier dietary patterns among females with diabetes compared to males [17,18], as well as with increasing age [18]. Cabrera et al., analyzing lifestyle factors in the CDC Canarias cohort, also found lower therapeutic adherence among males [42]. Another Spanish study in residents with diabetes in the region of Castilla León observed very high adherence to the Mediterranean diet and reported higher adherence among females [19].

The greater involvement of females in meal planning and preparation might partly explain these gender differences [43]. Furthermore, gender norms and social expectations may also influence gender differences in dietary behavior. In many cultures, women are socialized to prioritize caregiving roles and health-related responsibilities including food

preparation [43–45]. Women demonstrate more trust in healthy nutrition and a greater engagement in controlling body weight and select healthier food than men do [43–45]. The so-called "healthier" nutrition of women is also accompanied by greater nutritional knowledge and competence [43–45]. Education plays an important role in healthy nutrition; however, gender differences exist, and even when females have a lower formal education level, nutritional knowledge and engagement in preventive health behaviors remain higher for females than for males [45,46]. Also, females have a higher social pressure to reduce eating-related pleasure and to control body weight [43–45]. Wong et al. found that males with diabetes were more likely to eat the same meals as the rest of the family, while female patients were more likely to adjust their meals (i.e., reduce portions) or to prepare a separate meal for themselves to meet their nutritional requirements [43]. These psychosocial and cultural dimensions likely interact to promote healthier eating patterns among women with diabetes than among men with diabetes.

4.2. Age and Adherence to Nutritional Recommendations

We found that better adherence to nutritional recommendations was associated with older age among the participants with diabetes. The Western dietary patterns have been shifting away from agricultural products toward unhealthy fats, red and processed meats, and refined sugars [13–16]. The 2030 agenda promotes supporting local agriculture in developed countries, facilitating access to fresh, healthy, and sustainable food products [47]. Older adults in Mediterranean regions maintain traditional dietary habits more effectively than younger individuals [22,48], who face more challenging working conditions affecting healthy food consumption.

4.3. Physical Activity and Adherence to Nutritional Recommendations

Our study also revealed significantly lower PA levels among individuals with diabetes compared to those without, consistent with the available evidence [6]. Other national studies have similarly reported discouragingly low PA prevalence, consistently below the recommended levels [6]. These findings might even underestimate the true situation, as individuals with diabetes tend to overestimate their PA levels [49]. A systematic review reported PA adherence among people with diabetes ranging from 32% to 100%, with a median of 58% [50].

Female gender, older age, lower educational level, comorbidities, and smoking have been associated with lower PA levels in those with diabetes and the general population [6].

We observed higher adherence to nutritional recommendations among physically active individuals with diabetes than among patients with low PA levels. Although this subgroup might better control carbohydrate intake compared to more sedentary individuals, adherence to consumption recommendations for pasta, rice, potatoes, and bread remained low, despite a slightly higher adherence to nutritional recommendations for legumes. Even among the most active individuals, adherence was below 10% for pasta, rice, potatoes, and legumes.

Psychosocial factors may also play a key role in explaining why more physically active individuals with diabetes showed higher adherence to nutritional recommendations [51–53]. PA influences physiological processes such as appetite control and psychological aspects such as self-efficacy and body image, leading to greater self-determined motivation and, consequently, improvements in dietary self-regulation [51,52] Additionally, regular PA is known to enhance mood and cognitive function, potentially improving decision-making and reducing emotional eating [53]. Moreover, higher health consciousness and intrinsic motivation among physically active individuals may promote a broader commitment to healthy living, including better dietary choices [54].

Males with diabetes exhibited higher adherence to PA recommendations compared to females, which aligns with the existing literature indicating that males consistently engage in more moderate-to-vigorous PA throughout life [55]. Barriers to PA among females include lower social support and motivation and feelings of embarrassment, whereas males predominantly cite lack of time as a barrier [56].

4.4. Public Health Implications

Innovative strategies such as digitally delivered interventions are increasingly used to reduce sedentary behavior and promote PA in adults with diabetes [57,58]. A recent meta-analysis of randomized controlled trials concluded that these interventions increased PA and reduced sedentarism in adults with type 2 diabetes [57]. However, other meta-analyses showed that digital health interventions have not yet demonstrated substantial benefits over traditional care for chronic disease management, including diabetes, in European primary care [58].

In Spain, a 12-week, parallel, single-blind randomized controlled trial was conducted with 123 participants recently diagnosed with T2D to assess whether the Greenhabit (mobile health [mHealth]) behavioral treatment enhances T2D outcomes compared with standard care. The study found that PA significantly increased after the intervention [59]. However, also in our country, a two-arm randomized clinical trial involving primary care patients with T2DM to assess the impact of DiabeText, a new theory-based, patient-centered, mobile health intervention integrated with electronic health records to send tailored short text messages to support T2DM self-management, found that over a 12-month period, no statistically significant improvements were observed in adherence to the Mediterranean diet or in PA [60].

These digital approaches hold promises for overcoming traditional barriers to PA, and future public health strategies should incorporate these tools alongside tailored education to optimize outcomes in diabetes care. However, more research is needed to enhance the effectiveness of digital health interventions, address the current methodological limitations, and explore tailored approaches for both specific patient populations and multimorbid populations [57–60].

Our results reinforce the value of combining nutritional counseling and PA promotion within an integrated framework for diabetes management [61,62]. Individuals who reported moderate-to-high PA levels also exhibited better adherence to dietary recommendations, suggesting a synergistic relationship that could be leveraged in intervention design. Integrated lifestyle programs that simultaneously target diet and PA—particularly when adapted to cultural and sociodemographic contexts—have shown to be able to reduce diabetes incidence and to improve glycemic control, body composition, and cardiovascular outcomes among diabetes patients [61]. Economic evidence also indicates that these programs are cost-effective [62–64].

According to the current recommendations, interventions should include multiple sessions related to diet and PA, delivered in person or by other digital methods. These sessions must be provided within community-based programs, for at least three months, providing personalized lifestyle coaching, counseling, and extended support [61,62].

Our findings highlight the need for scalable, gender-sensitive, and age-appropriate programs that promote both dietary quality and PA in parallel [62–64].

4.5. Study Strength and Limitations

The strength of our study lies in the use of a large, structured health survey, allowing the analysis of nationally representative samples. This provides valuable epidemiological

data on health trends, lifestyle habits, and healthcare utilization, critical for health planning and evaluating public health programs.

However, our study has limitations worth noting. The cross-sectional design precludes causal inference. PA classification and dietary intake relied solely on self-reported frequencies, and therefore misclassification bias, such as recall and social desirability bias, must be considered [65]. The report of PA levels and dietary intake by diabetes patients could be affected by the fact that these patients are probably more strongly counseled by health professionals to engage in PA and a healthy diet than their healthy counterparts. Therefore, the lack of information about the advice that individuals received limits the internal validity of our findings. Furthermore, the lack of objective validation (e.g., accelerometer data) of PA is important and must be considered when interpreting the strength of the associations.

Regarding the validity of self-reported diabetes, a national study demonstrated specificity >95% and sensitivity >70% for self-reported diabetes using medical records as a gold standard [66]. Studies conducted in Spain and other countries agree on the validity of self-reported diabetes for epidemiological investigation [67–69]. However, we lacked specific information on diabetes such as type, complications, duration, and treatment. In Spain, the prevalence of type 1 diabetes is estimated to be around two cases per 1000 inhabitants, representing under 4% of all persons with diabetes in our country. Therefore, most adults with diabetes participating in our investigation would have had type 2 diabetes [70,71]. The absence of clinical data such as diabetes type or HbA1c levels limited the ability to stratify patients with disease severity. Future studies should incorporate these clinical endpoints.

We did not analyze the socioeconomic status because, in our country, the correlation of education level with socioeconomic status is high; so, we decided to include the educational level, as this variable is possibly more strongly associated with either PA or dietary habits. Additionally, the EESE does not include urban vs. rural residence data, which may influence dietary and PA patterns [72].

5. Conclusions

Spanish adults with diabetes exhibited greater dietary adherence than those without diabetes, though significant dietary gaps remained (e.g., fish, legumes). The PA levels remained critically insufficient among individuals with diabetes. Higher PA levels, female gender, and older age were associated with better adherence to nutritional recommendations. These findings can inform public health strategies promoting healthy lifestyles, emphasizing gender and age differences.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/nu17081382/s1, Table S1: Definition of variables according to the questions included in the European Health Interview Surveys in Spain conducted in the year 2020; Table S2: Distribution of participants with diabetes and matched controls without diabetes that achieved an adherence to five or more nutritional recommendations according to socio-demographic variables and physical activity level.

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Data Availability Statement: The anonymized EESE datasets are freely accessible and can be downloaded by anyone from the Ministry of Health's website https://www.sanidad.gob.es/estadEstudios/estadisticas/EncuestaEuropea/home.htm (accessed on 24 November 2024). All other relevant data are included in the paper.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

EESE	European Health Survey for Spain
MD	Mediterranean diet
PA	Physical activity

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8.3. Artículo 3

"Health care resource utilization among individuals with diabetes in Spain: Trends from population-based surveys, 2014–2020Utilización de recursos sanitarios en los sujetos con diabetes en España basada en encuestas poblacionales: tendencia de 2014 a 2020"

Luyi Zeng-Zhang, Natividad Cuadrado-Corrales, Rodrigo Jiménez-García, Ana López-de-Andrés, Zichen Ji, Jose J. Zamorano-León, Andrés Bodas-Pinedo, Ana Jiménez-Sierra, Elena Labajo-Gonzalez, Javier de Miguel-Diez.

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ORIGINAL ARTICLE

Health care resource utilization among individuals with diabetes in Spain: Trends from population-based surveys, 2014–2020

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KEYWORDS
Diabetes mellitus;
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Abstract
Background: Diabetes mellitus (DM) has a high health care burden. Understanding health care resource use in DM is essential for optimizing services. This study examines health care utilization among individuals with DM in Spain, comparing them to individuals without DM.
Methods: This study analyzed data from the 2014 and 2020 European Interview Health Survey for Spain (EHISS). Participants who reported a diagnosis of DM were classified as cases and matched to controls without DM by sex, age, EHISS edition and place of residence. The dependent variables studied were hospitalizations and emergency department visits during the 12 months. Independent variables included sociodemographics, lifestyle, and comorbidity factors.
Results: The study included a total of 7854 participants (3927 cases and 3927 controls). A comparison between 2014 and 2020 showed fewer hospitalizations (19.0% vs 16.1%, $p = 0.018$) and emergency department visits (36.2% vs 28.7%, $p < 0.001$) among individuals with DM. Individuals with DM had significantly higher rates of hospitalization (17.5% vs 11.1%; $p < 0.001$) and emergency department visits (32.3% vs 24.6%; $p < 0.001$) vs those without DM. The identified common

Abbreviations: DM, diabetes mellitus; EHISS, European Health Interview Survey for Spain; COPD, chronic obstructive pulmonary disease; VIF, variance inflation factor; OR, odds ratio; CI, confidence interval.

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predictors of hospitalization and emergency department visits were poor self-rated health and cardiac ischemia.
Conclusion: We observed a higher health care utilization among individuals with DM and a downward trend from 2014 to 2020. Identifying predictors of health care use may facilitate the development of interventions to reduce health care costs. The results should be interpreted with caution due to limitations, particularly the lack of data on DM type and glycemic control.

PALABRAS CLAVE
Diabetes mellitus;
Utilización de recursos sanitarios;
Encuestas de salud;
Hospitalizaciones;
Urgencias

Utilización de recursos sanitarios en los sujetos con diabetes en España basada en encuestas poblacionales: tendencia de 2014 a 2020

Resumen
Introducción: La diabetes mellitus (DM) supone un alto coste sanitario. Comprender el uso de los recursos sanitarios en personas con DM resulta esencial para optimizar los servicios. Este estudio analiza la utilización de recursos sanitarios en pacientes con DM en España, comparándolas con personas sin DM.
Métodos: Se analizaron datos procedentes de la Encuesta Europea de Salud en España (EESE) de los años 2014 y 2020. Se consideraron casos los que reportaban tener DM, y se emparejaron con controles sin DM por sexo, edad, edición de la *European Health Interview Survey for Spain* (EHISS) y lugar de residencia. Las variables dependientes fueron las hospitalizaciones y las visitas a servicios de urgencias en los 12 meses previos. Las variables independientes incluyeron factores sociodemográficos, de estilo de vida y de comorbilidad.
Resultados: Se incluyeron 7.854 participantes (3.927 casos y 3.927 controles). La comparación entre los años 2014 y 2020 mostró un descenso en las hospitalizaciones (19,0% vs. 16,1%; $p = 0,018$) y en las visitas a urgencias (36,2% vs. 28,7%; $p < 0,001$) entre las personas con DM. Estas presentaron tasas más altas de hospitalización (17,5% vs. 11,1%; $p < 0,001$) y de visitas a urgencias (32,3% vs. 24,6%; $p < 0,001$) en comparación con las personas sin DM. Los factores predictores comunes de hospitalización y de visitas a urgencias fueron la percepción negativa del estado de salud y la cardiopatía isquémica.
Conclusión: Las personas con DM presentan una mayor utilización de recursos sanitarios, y se observó una tendencia descendente entre 2014 y 2020. La identificación de los factores predictores de uso de recursos sanitarios puede facilitar el diseño de intervenciones para reducir los costes asistenciales. Sin embargo, los resultados deben interpretarse con precaución debido a las limitaciones, especialmente la ausencia de información sobre el tipo de DM y el nivel de control glucémico.

Introduction

Diabetes mellitus (DM) is a chronic disease with a high global prevalence whose impact on public health has steadily increased over the past decades.[1] In 2024, the global prevalence was estimated at 11.1%, representing a considerable health care and economic burden.[1,2] Between 2007 and 2024, global health care spending associated with DM increased by 338%, rising from 232 billion dollars to 1.015 trillion dollars.[2] Expenditure in Europe amounts to 193 billion, equivalent to 19% of the global total, making it the continent with the second highest average cost per person with DM.[2]

In Europe, Spain ranks 5th in the number of people with DM, with an estimated prevalence in the adult population of 13.1% and 35.5% of which are undiagnosed cases. Worldwide, the proportion of undiagnosed DM reaches approximately 4 out of 10 cases, with a higher prevalence of undiagnosed individuals observed in regions with insufficient access to health care systems and low socioeconomic status.[2,3] This issue is particularly relevant, as early diagnosis improves DM management, prevents complications, and enhances quality of life.[4]

In Spain, the average spending per person with DM was $2808.90.[2] The Spanish National Health System provides universal coverage, mainly funded through taxes.[5,6] The portfolio of services is extensive, although co-payment is required for drugs; however, out-of-pocket payments generally do not represent an unaffordable expense for households.[5,6] Therefore, these data are particularly rele-

vant in the Spanish context, as they highlight the elevated demand for health care services among individuals with DM in the form of frequent hospitalizations and emergency visits. This increased health care resources consumption puts a growing pressure on available resources, such as hospital capacity, specialized care, and public health expenditures, which further burdens a system already challenged by an aging population and the rising prevalence of chronic diseases.[5,7]

From a clinical point of view, DM entails both acute and chronic complications that increase the need for health care. Acute decompensations, such as diabetic ketoacidosis, hyperosmolar hyperglycemic syndrome, and hypoglycemia, are common causes of visits to emergency departments.[8] In the long term, DM is associated with a high risk of cardiovascular and cerebrovascular disease, including ischemic heart disease, stroke, and peripheral arterial disease,[9] potentially leading to increased hospitalizations and follow-up in specialized outpatient clinics. As a microvascular complication, diabetic nephropathy is the leading cause of renal replacement therapy in Spain, with a significant impact on health care expenditure.[10] The coexistence of multiple chronic conditions in people with DM, such as hypertension, dyslipidemia, or mental illness, further increases the use of health care services and complicates the clinical management of these patients.[9]

Despite the size of the problem, few recent studies have systematically addressed the use of health care resources in people with DM in Spain. Most of the currently available studies are becoming outdated. Current data and understanding of recent trends in this field are essential for proper health care planning and efficient allocation of available resources.

The objectives of the present study were (1) to analyze the evolution of health care resource utilization in Spain between 2014 and 2020 among people with DM, considering hospitalizations and emergency care; (2) to compare usage between individuals with and without DM based on sociodemographic characteristics, lifestyle, and comorbidities; and (3) to identify the factors associated with greater use of health care resources in both groups.

Materials and methods

Design

We conducted a retrospective observational study using data from the European Health Interview Survey for Spain (EHISS) from 2014 and 2020 editions. This survey was developed by the Spanish National Statistics Institute and targeted residents of Spain aged 15 years or older. Data from both editions had been collected through face-to-face interviews until March 2020, when telephone interviews began due to the restrictions following the COVID-19 pandemic.[11] This change in the way the interview was conducted could lead to differences in the quality of the data collected.

The sampling design of the EHISS was probabilistic, stratified, and multistage. First, geographic units (census sections) were randomly selected, followed by a random sampling of households, and finally, one individual per household was chosen. This procedure ensured the representativeness of the general Spanish population.[11]

Cases and controls

Participants who answered affirmatively to the question, ''Has a doctor ever told you that you have DM?'' were considered cases. Those who answered negatively to the same question were classified as controls. Each case was matched with a control adjusting for sex, age, survey edition, and autonomous community of residence, to reduce potential confounding factors. Given that this classification is based on self-reported diagnoses, it may be subject to recall bias or misclassification, which could affect the reliability of case identification.[12]

Analyzed variables

The dependent variables analyzed were 2 indicators of health care resource use in the past 12 months: at least, 1 hospitalization and visit to emergency services. Independent variables included sociodemographic characteristics, such as sex, age, educational level, living with a partner, and survey edition), lifestyle-related factors (BMI, self-rating of health status, active smoking, alcohol consumption, and sedentary lifestyle), and the presence of relevant comorbidities (COPD, cardiac ischemia, stroke, cancer, mental disease, hypertension, dyslipidemia, and chronic pain). Definitions and categories of variables are detailed in Table S1.

Statistical analysis

We conducted a descriptive analysis of the sample. Quantitative variables with normal distribution were expressed as mean and standard deviation (SD), and those without normal distribution according to the Kolmogorov–Smirnov test as median and interquartile range (IQR). Qualitative variables were described as frequencies and percentages.

To compare groups, the following tests were used: Student's *t*-test for quantitative variables with normal distribution, Mann–Whitney *U* test for quantitative variables without normal distribution, and the chi-square test for categorical variables.

To identify factors associated with health care resource utilization, 2 multivariable logistic regression models were developed, one for each dependent variable. All variables collected in the study were initially included as potential predictors. Variable significance was assessed using the Wald statistic, and non-significant variables were removed through a backward elimination process. Multicollinearity was evaluated using the variance inflation factor (VIF). All tolerance values were >0.70, and all VIF values were <1.5, indicating the absence of problematic multicollinearity. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test. Results are presented as odds ratios (OR) with corresponding 95% confidence intervals (CI).

SPSS Statistics software, version 26.0 (IBM Corp., Armonk, NY, USA), was used, and a two-tailed *p*-value of <0.05 was considered statistically significant for all comparisons.

Ethical considerations

Access to the survey data is free and open.[9] Because the data were anonymized and analyzed in aggregate, national legislation did not require written informed consent or approval by a Research Ethics Committee for medicinal products.

Results

A total of 7854 participants were included, including 3927 cases and 3927 controls. Of these, 1912 (48.7%) were men. The mean age was 68.89 years (SD, 13.1). Table S2 shows the comparison of clinical characteristics between groups with and without DM. Compared to participants without DM, patients with DM had a significantly higher median body mass index (BMI) (27.82 vs 26.22; $p < 0.001$), more sedentary habits (50.2% vs 41.3%; $p < 0.001$) and unfavorable self-rated health status (62.9% vs 43.6%; $p < 0.001$), but lower alcohol consumption (38.6% vs 48.7%; $p < 0.001$). The prevalence of all studied comorbidities was higher in the DM group, except for cancer, for which no significant differences were found.

Table S3 illustrates the characteristics by survey edition. Comparisons between the 2014 and 2020 surveys showed an increase in mean age (69.6 vs 68.1 years; $p < .001$) and a modest reduction in mean BMI (27.5 vs 28.0; $p < .001$). Participants in 2020 had a higher level of education and a greater proportion reported favorable self-rated health (40.0% vs 33.8%; $p < .001$). The prevalence of mental illness (18.9% vs 23.7%; $p < .001$) and chronic obstructive pulmonary disease (8.8% vs 12.2%; $p < .001$) was lower in 2020 vs 2014.

Fig. 1 illustrates the evolution in health care resource use from 2014 to 2020, based on the presence or absence of DM. A significant decrease was observed in the proportion of participants with DM visiting an emergency department (36.2% vs 28.7%; $p < 0.001$), as well as a reduction in the proportion of participants requiring hospitalizations (19.0% vs 16.1%; $p = 0.018$).

Table 1 illustrates the hospitalizations of participants with and without DM according to sociodemographic variables, lifestyle, and comorbidities, from EHISS 2014 and 2020 editions. A higher frequency of hospitalization was observed in the DM group (17.7%) vs those without DM (11.1%), with the difference being statistically significant ($p < 0.001$). This trend persisted across most categories analyzed, except for subgroups with low weight, a history of stroke, or cancer, where no relevant differences were found.

Among participants with DM, hospitalization was significantly associated with older age, low educational level, unfavorable self-rated health status, sedentary lifestyle, absence of alcohol or tobacco use, hypertension, cardiac ischemia, mental disease, and chronic pain. Additionally, hospitalization rates were significantly higher in participants from the 2014 vs the 2020 survey, showing a decrease in hospitalizations during this period. In the group without DM, similar associations were identified, except for the survey edition, which did not show significant differences.

Table 2 illustrates the prevalence of emergency department visits according to sociodemographic variables, lifestyle, and comorbidities, in individuals with and without DM, based on EHISS 2014 and 2020 data. Greater use of these services was found in the DM vs the non-DM group (32.2% vs 24.6%; $p < 0.001$). This difference persisted in most subcategories, except for individuals with low weight, higher educational level, or a history of stroke or cancer.

Among individuals with DM, emergency visits were associated with female sex, high BMI, low educational level, unfavorable self-rated health, sedentary lifestyle, no alcohol consumption, hypertension, dyslipidemia, cardiac ischemia, stroke, mental disease, COPD and chronic pain. Furthermore, emergency room visits were significantly higher in participants from the 2014 vs the 2020 survey, suggesting a temporal decline over this period. Similar associations were found in the group without DM, with additional differences in non-smoking and history of cancer, and no significant variation according to survey year.

Table 3 illustrates the predictors of hospitalization based on DM diagnosis. A diagnosis of DM was significantly associated with a higher likelihood of hospitalization (OR, 1.33; 95%CI, 1.15–1.53). In the DM group, factors that increased risk included male sex (OR, 1.30; 95%CI, 1.09–1.61), unfavorable self-rated health (OR, 2.77; 95%CI, 2.17–3.54), sedentary lifestyle (OR, 1.23; 95%CI, 1.01–1.49), cardiac ischemia (OR, 2.11; 95%CI, 1.66–2.67), history of stroke (OR, 1.46; 95%CI, 1.06–2.01), cancer (OR, 1.61; 95%CI, 1.21–2.15), and COPD (OR, 1.65; 95%CI, 1.27–2.13). Dyslipidemia showed an inverse association (OR, 0.77; 95%CI, 0.64–0.94).

Table 4 illustrates the predictors of emergency visits based on the presence or absence of DM. A DM diagnosis was associated with a higher likelihood of using emergency services (OR, 1.13; 95%CI, 1.02–1.26). The DM group showed positive associations with unfavorable self-rated health (OR, 2.04; 95%CI, 1.70–2.44), cardiac ischemia (OR, 1.48; 95%CI, 1.19–1.85), history of stroke (OR, 2.02; 95%CI, 1.51–2.70), mental disease (OR, 1.71; 95%CI, 1.42–2.06), COPD (OR, 1.36; 95%CI, 1.08–1.71), and chronic pain (OR, 1.37; 95%CI, 1.17–1.61). Participation in the 2020 edition (OR, 0.82; 95%CI, 0.71–0.95) was associated with a lower likelihood of emergency visits. No significant differences were observed between sexes.

Discussion

Our study found a significant decrease between 2014 and 2020 in the proportion of participants with DM who made at least 1 emergency department visit and in the participants who were hospitalized. These results are similar to those obtained in a study conducted in Spain that found a decrease from 2007 through 2015 in the prevalence of hospitalization of individuals with DM.[13] This trend has also been observed in other studies conducted in Spain [14] and as well as in a population-based study conducted in Poland during the same period (2014–2020), where a decrease in hospitalization rates was observed among the population with DM.[15] In contrast, a study conducted in Ghana showed a progressive increase in the percentage of patients with hospitalizations from 2012 through 2017 (from 7.9% up to 21.6%).[16] In the United States, a study analyzed the prevalence of emergency department visits among individuals with DM and reported a 55.6% increase from 2008 to 2017.[17] A study conducted in Saudi Arabia between 2011 and 2015 also observed an increase, of 21%.[18] These disparities in health care utiliza-

Table 1 Prevalence of hospitalization by demographic, lifestyle, and comorbidity variables among participants with and without diabetes based on the 2014 and 2020 editions of the European Health Interview Surveys for Spain (EHISS).

Variable	Categories	Diabetes		No diabetes		*P* value
		n	%	*n*	%	
Total		687	17.5	436	11.1	<0.001
Sex	Male	338	17.7	222	11.6	<0.001
	Female	349	17.3	214	10.6	<0.001
Age groups (years old)[A,B]	≤49	38	12.0	12	3.8	<0.001
	50–59	85	15.3	40	7.2	<0.001
	60–69	160	16.2	116	11.7	0.004
	70–79	205	17.5	135	11.5	<0.001
	≥80	199	22.1	133	14.8	<0.001
BMI category	Underweight < 1 8.5	3	16.7	7	14.9	1.000
	Normal weight 18.5–24.9	162	18.6	132	10.2	<0.001
	Overweight 25.0–29.9	250	16.0	174	10.8	<0.001
	Obesity ≥ 30	208	17.7	88	12.5	0.003
Educational level[A,B]	No studies/primary	226	20.4	117	14.0	<0.001
	Secondary	415	16.7	274	10.7	<0.001
	High education	46	13.8	45	8.5	0.014
Living with a partner	No	327	18.1	205	11.5	<0.001
	Yes	360	16.9	231	10.8	<0.001
Self-rated health[A,B]	Fair/poor/very poor	578	23.4	326	19.0	<0.001
	Very good/good	109	7.5	110	5.0	0.002
Active smoking[A,B]	No	601	18.0	395	11.9	<0.001
	Yes	86	14.6	41	6.9	<0.001
Alcohol consumption[A,B]	No	465	19.3	259	12.9	<0.001
	Yes	222	14.7	177	9.3	<0.001
Sedentary lifestyle[A,B]	No	272	13.9	204	8.8	<0.001
	Yes	415	21.1	232	14.3	<0.001
Hypertension[A,B]	No	230	15.7	218	9.6	<0.001
	Yes	457	18.6	218	13.1	<0.001
Dyslipidemia	No	334	17.5	287	10.6	<0.001
	Yes	353	17.5	149	12.2	<0.001
Cardiac ischemia[A,B]	No	528	15.3	369	10.1	<0.001
	Yes	159	33.3	67	25.6	0.028
Stroke[A,B]	No	613	16.7	392	10.3	<0.001
	Yes	74	30.0	44	32.1	0.661
Cancer[A,B]	No	597	16.5	372	10.3	<0.001
	Yes	90	28.3	64	22.5	0.105
Mental disease[A,B]	No	479	15.5	338	10.2	<0.001
	Yes	208	25.0	98	15.9	<0.001
COPD[A,B]	No	562	16.0	337	10.3	<0.001
	Yes	125	30.5	59	22.7	0.028
Chronic pain[A,B]	No	348	15.1	237	9.3	<0.001
	Yes	339	20.9	199	14.5	<0.001
EHISS[A]	2014	356	19.0	208	11.1	<0.001
	2020	331	16.1	228	11.1	<0.001

COPD: chronic obstructive pulmonary disease.
p value for difference between participants with diabetes and diabetes age and sex matched controls.
[A] Significant association between the variable and Hospitalization among participants with Diabetes.
[B] Significant association between the variable and Hospitalization among participants without Diabetes.

Table 2 Prevalence of emergency department visits by demographic, lifestyle, and comorbidity variables among participants with and without diabetes based on the 2014 and 2020 editions of the European Health Interview Surveys for Spain (EHISS).

Variable	Categories	Diabetes		No diabetes		*P* value
		n	%	*n*	%	
Total		1267	32.3	965	24.6	<0.001
Sex[A,B]	Male	555	29.0	384	20.1	<0.001
	Female	712	35.3	581	28.8	<0.001
Age groups (years old)[A,B]	≤49	111	35.0	72	22.7	<0.001
	50–59	168	30.3	112	20.2	<0.001
	60–69	281	28.4	227	23.0	0.005
	70–79	352	30.1	288	24.6	0.003
	≥80	355	39.5	266	29.6	<0.001
BMI category[A,B]	Underweight <1 8.5	5	27.8	17	36.2	0.573
	Normal weight 18.5–24.9	266	30.5	300	23.3	<0.001
	Overweight 25.0–29.9	475	30.3	379	23.5	<0.001
	Obesity ≥ 30	412	35.1	200	28.4	0.003
Educational level[A,B]	No studies/primary	438	39.6	269	32.1	<0.001
	Secondary	748	30.1	593	23.2	<0.001
	High education	81	24.3	103	19.5	0.093
Living with a partner[B]	No	601	33.4	471	26.4	<0.001
	Yes	666	31.3	494	23.0	<0.001
Self-rated health[A,B]	Fair/poor/very poor	1009	40.8	628	36.6	0.006
	Very good/good	258	17.7	337	15.2	0.045
Active smoking[B]	No	1077	32.3	844	25.3	<0.001
	Yes	190	32.3	121	20.3	<0.001
Alcohol consumption[A,B]	No	851	35.3	558	27.7	<0.001
	Yes	416	27.5	407	21.3	<0.001
Sedentary lifestyle[A,B]	No	527	26.9	494	21.4	<0.001
	Yes	740	37.6	471	29.1	<0.001
Hypertension[A,B]	No	420	28.6	494	21.8	<0.001
	Yes	847	34.5	471	28.4	<0.001
Dyslipidemia[A,B]	No	564	29.6	628	23.2	<0.001
	Yes	703	34.8	337	27.6	<0.001
Cardiac ischemia[A,B]	No	1047	30.3	865	23.6	<0.001
	Yes	220	46.1	100	38.2	0.037
Stroke[A,B]	No	1137	30.9	898	23.7	<0.001
	Yes	130	52.6	67	48.9	0.484
Cancer[B]	No	1149	31.8	873	24.0	<0.001
	Yes	118	37.1	92	32.4	0.226
Mental disease[A,B]	No	406	48.8	239	38.7	<0.001
	Yes	208	25.0	98	15.9	<0.001
COPD[A,B]	No	1074	30.5	864	23.6	<0.001
	Yes	193	47.1	101	38.8	0.037
Chronic pain[A,B]	No	591	25.6	490	19.2	<0.001
	Yes	676	41.7	475	34.7	<0.001
EHISS[A]	2014	678	36.2	483	25.8	<0.001
	2020	589	28.7	482	23.5	<0.001

COPD: chronic obstructive pulmonary disease.
p value for difference between participants with diabetes and diabetes age and sex matched controls.
[A] Significant association between the variable and Emergency Department Visits among participants with Diabetes.
[B] Significant association between the variable and Emergency Department Visits among participants without Diabetes.

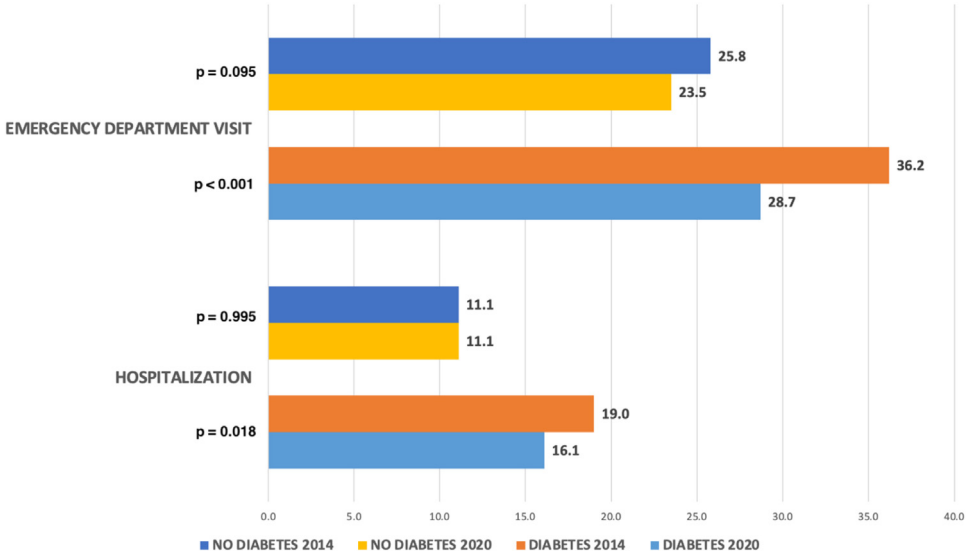

Figure 1 Health care resource use among participants with and without diabetes based on EHISS editions.

Table 3 Predictors of hospitalization based on diabetes diagnosis.

Variables	Categories	DiabetesOR (95%CI)	No DiabetesOR (95%CI)	Both OR (95%CI)
Sex	Male	1	1	1
	Female	0.77 (0.62–0.95)	0.67 (0.52–0.87)	0.72 (0.62–0.85)
Age groups (years old)	≤49	1	1	1
	50–59	NS	NS	NS
	60–69	NS	2.19 (1.16–4.12)	1.43 (1.03–1.99)
	70–79	NS	NS	NS
	≥80	NS	NS	NS
Self-rate health	Very good/good	1	1	1
	Fair/poor/very poor	2.77 (2.17– 3.54)	3.46 (2.62–4.55)	3.19 (2.67–3.81)
Active smoking	No	1	1	1
	Yes	NS	0.56 (0.38–0.82)	0.75 (0.60–0.93)
Sedentary lifestyle	No	1	1	1
	Yes	1.23 (1.01–1.49)	NS	1.18 (1.00–1.39)
Dyslipidemia	No	1	1	1
	Yes	0.77 (0.64–0.94)	NS	0.81 (0.70–0.94)
Cardiac ischemia	No	1	1	1
	Yes	2.11 (1.66–2.67)	1.83 (1.30–2.58)	1.98 (1.65–2.39)
Stroke	No	1	1	1
	Yes	1.46 (1.06–2.01)	2.52 (1.65–3.85)	1.69 (1.33–2.15)
Cancer	No	1	1	1
	Yes	1.61 (1.21–2.15)	1.68 (1.21–2.35)	1.34 (1.23–2.03)
COPD	No	1	1	1
	Yes	1.65 (1.27–2.13)	1.89 (1.34–2.67)	1.66 (1.36–2.02)
Diabetes	No	NA	NA	1
	Yes	NA	NA	1.33 (1.15–1.53)

NS: not significant; NA: not applicable.
COPD: chronic obstructive pulmonary disease.

Table 4 Predictors of emergency department visits based on diabetes diagnosis.

Variables	Categories	DiabetesOR (95%CI)	No diabetesOR (95%CI)	Both OR (95%CI)
Sex	Male	1	1	1
	Female	NS	1.27 (1.06–1.53)	1.13 (1.02–1.27)
Educational level	No studies/primary	1	1	1
	Secondary	NS	NS	0.85 (0.74–0.96)
	High education	NS	NS	NS
Self-rate health	Very good/good	1	1	1
	Fair/poor/very poor	2.04 (1.70–2.44)	2.29 (1.89–2.77)	2.31 (2.04–2.61)
Cardiac ischemia	No	1	1	1
	Yes	1.48 (1.19–1.85)	1.61 (1.20–2.17)	1.54 (1.30–1.82)
Stroke	No	1	1	1
	Yes	2.02 (1.51–2.70)	1.97 (1.33–2.91)	1.93 (1.55–2.40)
Mental disease	No	1	1	1
	Yes	1.71 (1.42–2.06)	1.37 (1.11–1.69)	1.53 (1.34–1.74)
COPD	No	1	1	1
	Yes	1.36 (1.08–1.71)	1.43 (1.07–1.93)	1.47 (1.24–1.75)
Chronic pain	No	1	1	1
	Yes	1.37 (1.17–1.61)	1.43 (1.20–1.71)	1.41 (1.26–1.58)
EHISS	2014	1	1	1
	2020	0.82 (0.71–0.95)	NS	0.86 (0.78–0.96)
Diabetes	No	NA	NA	1
	Yes	NA	NA	1.13 (1.02–1.26)

NS: not significant; NA: not applicable.
COPD: chronic obstructive pulmonary disease.

tion trends across countries worldwide may be explained by differences in access to health care systems, socioeconomic status, and barriers related to health policy.[19]

Declines in health care utilization observed between 2014 and 2020 may be indicative of systemic improvements in the management of DM, such as greater specialist endocrinology availability.[20] Nevertheless, since our analysis lacked data on the causes of hospitalizations and emergency department visits, we cannot conclude that this trend is explained by any single factor. New non-insulin hypoglycemic drugs have recently become available with public funding in Spain. While our study does not include data on treatment or glycemic control, it is plausible that the introduction of these therapies may have contributed to improved disease management, potentially reducing complications and emergency visits among patients with DM.[21] However, this remains a hypothesis that cannot be confirmed with the current data.

During the COVID-19 pandemic, which had a significant impact in Spain, Spanish authorities implemented measures that limited the mobility of the population.[22] These measures, together with the fear of infection, especially among people with different degrees of immunosuppression, including patients with DM, led to lower utilization of health care resources for reasons other than COVID-19.[23] Additionally, during this period, non-urgent medical activities were suspended, prioritizing care for COVID-19-related cases.[22,23] This disruption in routine care and monitoring represents a major limitation for interpreting our results during the most recent period, as it may have influenced health care utilization independently of underlying health needs. A study analyzing the impact of COVID-19 restriction measures showed a decrease in testing of glycosylated hemoglobin in the population with DM vs the same periods of the previous year.[22] However, other studies have reported opposite findings, showing a deterioration in glycemic control in the context of high systemic inflammation caused by COVID-19 infection. Therefore, during the pandemic, the high rate of infections may have been a contributing factor to poorer disease control among patients with DM.[24,25]

Our study showed that the hospitalization rate in the population with DM was 1.6 times higher than in the population without DM, a finding consistent with other findings described in the literature.[26,27] The increase in the prevalence of hospitalization with age is similar to that observed in a study conducted in Ghana in the population with DM,[16] which showed a higher prevalence of hospitalization in the 75–79 age group vs the 25–29 age group.

Our study found a higher probability of hospitalization in men with DM. Although several studies in the literature have examined hospitalization rates in patients with DM by sex, results are inconsistent, probably due to gender bias, study design, and demographic and social differences. Several former studies found women have both a higher mortality and a higher risk of hospitalization due to cardiovascular disease.[28]

On the other hand, in our study, a positive association was observed between DM and other comorbidities such as cardiac ischemia, stroke, cancer, mental disease, COPD, and

chronic pain. These findings are similar to those described in a study that reported a higher prevalence of hypertension, chronic kidney disease, coronary artery disease, and heart failure in the population with vs without DM.[26]

A study conducted by Assari et al. (2020) observed a positive relationship between poor self-rated health and greater utilization of health care resources, including both emergency visits and hospitalizations.[29] This finding is similar to our study conclusions. Former studies have identified self-rated health as a valid and reliable predictor of mortality.[30,31] It is also consistently associated with multimorbidity,[32] a factor that contributes to a higher emergency room visits and hospital admissions.

In our study, we found an association between hospitalization and being a non-smoker, although this was not statistically significant within the subgroup of patients with DM. One possible explanation is the healthy survivor effect or reverse causality, whereby individuals may adopt healthier behaviors, such as quitting smoking, following hospitalization or complications from chronic diseases.[33]

Similarly, we observed an inverse association between dyslipidemia and hospitalization. A possible explanation is that individuals diagnosed with both dyslipidemia and DM are usually having a stricter medical supervision and a more regular follow-up.[34] This could potentially lead to a better prevention of acute complications and, as a result, a lower likelihood of hospitalization. However, further studies are needed to corroborate this hypothesis.

Regarding emergency department visits, our study showed a higher prevalence of such visits in participants with DM vs without DM. This prevalence was especially higher in women. This finding was also reported in a 2022 study conducted by Uppal et al.[17] However, A prospective study led by Patel et al., conducted in the United States in 2022 revealed no differences in emergency visits between men and women with DM.[35]

Santo et al. demonstrated an increase in emergency visit rates as comorbidities increased.[36] The same phenomenon was observed in a study conducted by Ye et al.[37] The results of our study are consistent with those reported in the literature. Specifically, we found an association between mental illness and emergency visits. This is consistent with the findings from the studies conducted by Hutter et al. and Shulman et al., which proved more emergency visits and hospitalizations, and greater health care spending in individuals with DM and mental illness vs those with DM without mental illness.[38]

A study conducted in Mexico[39] identified higher educational level as a factor associated with a higher risk of emergency visits in the population with T1DM. In contrast, our study found a higher prevalence of emergency visits in patients with DM who had only primary education or no education. This difference is probably due to social disparities and the fact that our study did not distinguish between T1DM and T2DM.

To reduce excessive utilization of health care resources in the population with DM, it is important to strengthen both primary and specialized care for these individuals, paying special attention to those with comorbidities, which are associated with greater use of these resources. Other measures could include early detection and treatment of DM and its related microvascular and macrovascular complications, as well as DM education, with the goal of reducing the prevalence of emergency visits and hospitalizations.[40]

Our study has several strengths. First, the large sample size increases statistical power. Second, the survey methodology is consistent and uniform throughout the study period, allowing comparison between different survey editions and analysis of trends. Third, the face-to-face interview format and anonymity increase the credibility of the information. Finally, the survey includes sociodemographic and lifestyle variables, which facilitates study of social factors.

But, our study also has limitations as well. First, a fundamental limitation of this study is the inability to distinguish between T1DM and T2DM. This represents a significant limitation on results interpretability, as these diseases possess extremely different etiologies, management, complication spectra, and health care resources utilization patterns, so caution is needed when interpreting combined data. Second, we lacked data on the degree of disease control. Health care resource utilization may differ depending on glycemic control level. Third, the diagnosis of DM was self-reported by participants, without verification through medical records. This method may be subject to certain limitations, particularly the influence of recall bias and social desirability bias, which could compromise the reliability of the information provided. Although a study conducted among the Spanish population has shown good concordance between self-reported diagnoses and health records verification.[41] Fourth, since the survey questions refer to the past, recall bias may occur. Fifth, there may be non-response bias, considering that the response rate in EHISS 2014 was 74.6% and in EHISS 2020 was 72.2%.[42] Sixth, while the variable ''living with a partner'' was available, the caregiving roles were not captured by the surveys, which would be useful to inform the relationship between social support structures and health care utilization. Seventh, our study lacked adjustment for socioeconomic status and primary care access, which are determinants of health care resources utilization that may influence both DM outcomes and service use patterns. Finally, the difference in the mode of contact for conducting the interview, due to the impact of the COVID-19 pandemic, could affect the quality of the data collected by telephone and the comparability of these data with those collected in person. Considering these limitations, the results should be interpreted with caution.

Conclusions

Despite the downward trend in health care resource utilization among patients with DM, it remained higher vs patients without DM. Patients with DM, unfavorable self-perceived health status, and comorbidities were more likely to use health care resources. Greater attention should be given to these patients in routine clinical practice and in the design of health care strategies to prevent complications.

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Conflicts of interest

None declared.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.endinu.2025.501684.

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9. DISCUSIÓN

9.1. Adherencia a los cribados de cáncer ginecológicos y colorrectales

En el primer artículo, se observa un incremento significativo en la adherencia a los programas de cribado de cáncer cérvix y colorrectales en pacientes con DM entre 2014 y 2020, del 9% y 20% respectivamente. Este aumento sugiere una mayor concienciación y adherencia en la población en comparación con los años previos, donde se reportaban niveles más bajos[84,128].

En nuestro estudio, se identificó una menor adherencia a los cribados de cánceres ginecológicos en la población con DM en comparación con aquellos sin DM. No obstante, no se observaron diferencias significativas en la participación en el cribado mediante sangre oculta en heces entre ambos grupos. Estos hallazgos coinciden con resultados de estudios previos [84,128–131]. Una posible explicación de la menor adherencia podría ser que los pacientes con DM priorizan el control de su enfermedad metabólica, relegando los cribados oncológicos a un segundo plano [132,133]. De la misma manera, los médicos suelen dar prioridad a problemas sintomáticos y urgentes, lo que favorece la inercia clínica[131].

Respecto a los factores predictores de adherencia a la mamografía, se identificó la edad como un factor de mayor participación en ambos grupos[134,135]. La convivencia con la pareja también se asoció a mayor adherencia, en concordancia con otros estudios que sugieren que el apoyo social podría motivar la realización de pruebas de cribado[135]. En la población con DM, los antecedentes de cáncer se relacionaron igualmente con una mayor adherencia, probablemente debido a una mayor conciencia y precaución por los antecedentes[128].

En relación con el cribado cáncer de cérvix, un mayor nivel educativo se asoció a una mejor adherencia en ambos grupos. Este hallazgo es consistente con la literatura, donde

la educación superior se vincula con una mayor utilización de servicios preventivos, especialmente en el caso de cáncer de cérvix, cuyo cribado se basa en un sistema oportunista[135,136]. En la población con DM, la edición más reciente de la encuesta también se asoció de manera positiva con la adherencia, en consonancia con el incremento observado entre 2014 a 2020.

En cuanto al cribado mediante sangre oculta en heces, tanto el nivel educativo elevado como la edición de la encuesta 2020 fueron predictores de mayor adherencia. La mejoría progresiva observada en este ámbito podría explicarse por los distintos periodos de implementación de los programas de cribado de cáncer colorrectal[125].

En síntesis, nuestros hallazgos subrayan la necesidad de diseñar programas educativos dirigidos tanto a la población con DM como a los profesionales, enfatizando la importancia de la realización de cribados oncológicos. Estrategias como recordatorios telefónicos, correos electrónicos o notificaciones postales podrían favorecer la participación.

9.2. Adherencia a las recomendaciones nutricionales y actividad física

El principal hallazgo de este estudio fue una mayor adherencia a las recomendaciones nutricionales entre la población con DM en comparación con la de aquellos sin esta enfermedad. Este resultado es consistente con los estudios previos realizados, que comparan los hábitos dietéticos entre población con y sin DM[99,100,137,138]. En un estudio italiano realizado por Tatoli et al. en el que se incluyeron 187 adultos con y sin DM, se reportó una mayor diferencia dietética, con elecciones más saludables en aquellos con DM, cuyos patrones dietéticos fueron descritos como “vegetarianos”[137]. El estudio realizado por Huffman et al. analizó poblaciones afroamericanas y haitianas-americanas con y sin DM, encontrando patrones dietéticos más saludables en aquellos con DM

mediante el índice Alternativo de Alimentación saludable, basado en datos del cuestionario de frecuencia de consumo de alimentos de Harvard. Además, los patrones fueron menos favorables en los afroamericanos en comparación con los haitiano-americanos, lo que resalta la importancia de la entidad en los estudios[138]. No obstante, en un análisis transversal irlandés de 111 personas, se objetivaron puntuaciones significativamente más bajas en el patrón dietético mediterráneo en los individuos con DM en comparación con los controles, medidos mediante la Escala de Dieta Mediterránea y Escala de Dieta Mediterránea Alternativa[139]. En España, en un estudio realizado por Vidal-Peracho et al., con una muestra de 197 adultos con DM y controles, se reportaron mayores puntuaciones de adherencia a la dieta mediterránea en las personas con DM[100]. De manera similar, Alcubierre et al. informaron de patrones dietéticos más saludables en 238 individuos con DM, utilizando el Índice de Dieta Mediterránea Alternativo y el Índice Alternativo de Alimentación Saludable[99].

En nuestro análisis específico por género, las mujeres mostraron consistentemente una mayor adherencia dietética que los hombres en todos los subgrupos poblacionales. Este hallazgo es concordante con el estudio TOSCA.IT, en el que se incluyeron 2574 adultos italianos con DM, identificándose una mayor adherencia a la dieta mediterránea en las mujeres, los individuos de mayor edad y los residentes de las regiones del sur[140]. El estudio dirigido por Zanetti et al., que incluyó 423 individuos con DM, reportó una mayor adherencia dietética en las mujeres, los individuos con mayor nivel educativo y aquellos con menor estatus socioeconómico[141]. Se encontraron resultados similares en otros estudios realizados en España, en los que se demostró una mayor adherencia terapéutica y a dieta mediterránea en las mujeres[99,100,142].

La mayor participación de las mujeres en la planificación y preparación de las comidas podría explicar en parte estas diferencias de género[143]. Además, las expectativas sociales también podrían influir en las diferencias de género en relación al comportamiento alimentario. En muchas culturas, las mujeres adoptan roles de cuidado y responsabilidades relacionadas con la salud, incluida la preparación de alimentos[143–145]. Las mujeres demuestran una mayor confianza en la nutrición saludable y un mayor compromiso en el control de peso corporal y seleccionan alimentos más saludables que los hombres[143–145]. La educación desempeña un papel importante en la nutrición saludable; sin embargo, existen diferencias de género. Aun cuando las mujeres tienen un nivel educativo más bajo, el conocimiento nutricional y el compromiso en conductas de salud preventiva siguen siendo mayor en las mujeres que en los hombres[145,146]. Wong et al. encontraron que los hombres con DM eran más propensos a comer las mismas comidas que el resto de la familia, mientras que las pacientes mujeres eran más propensas a ajustar sus comidas o a preparar una comida separada para ellas mismas a fin de cumplir con sus requerimientos nutricionales[143]. Estos determinantes psicosociales y culturales probablemente interactúan para promover patrones de alimentación más saludables en las mujeres con DM en comparación con los hombres con esta enfermedad.

Por otro lado, se encontró que una mayor edad en los participantes con DM se asociaba con una mejor adherencia a las recomendaciones nutricionales. Los adultos mayores en las regiones mediterráneas mantienen los hábitos dietéticos tradicionales de manera más efectiva que los individuos más jóvenes[147,148], quienes enfrentan condiciones laborales más exigentes que afectan el consumo de alimentos saludables.

Nuestro estudio también reveló niveles significativamente más bajos de AF entre las personas con DM en comparación con aquellas sin esta enfermedad, hallazgo concordante con otro estudio realizado a nivel nacional[108]. Estos hallazgos podrían incluso subestimar la situación real, ya que las personas con DM tienden a subestimar sus niveles de AF[149]. En una revisión sistemática se describió que la adherencia a la AF en las personas con DM variaba del 32% al 100%, con una mediana del 58%[150]. El género femenino, la mayor edad, el menor nivel educativo, las comorbilidades y el tabaquismo se asociaban con niveles más bajos de AF en personas con DM y en la población general[108].

Observamos una mayor adherencia a las recomendaciones nutricionales en los individuos físicamente activos con DM que en los pacientes con bajo niveles de AF. Aunque este subgrupo podría controlar mejor la ingesta de carbohidratos en comparación con individuos más sedentarios, la adherencia a las recomendaciones de consumo de pasta, arroz, patatas y pan seguía siendo baja, a pesar de una adherencia ligeramente mayor a las recomendaciones nutricionales para las legumbres. Incluso en los individuos más activos, la adherencia fue inferior al 10% para pasta, arroz, patata y legumbres.

Los factores psicosociales también pueden desempeñar un papel clave para explicar los motivos de la mayor adherencia entre los individuos con DM físicamente más activos[151–153]. La AF influye en procesos fisiológicos como el control del apetito y en aspectos psicológicos como la autoestima y la imagen corporal, lo que conduce a una mayor motivación y mejor autorregulación dietética[151,152]. Además, la AF regula el estado de ánimo y la función cognitiva, lo que potencialmente mejora la toma de decisiones y reduce la ingesta emocional[153]. Asimismo, una mayor conciencia de la salud y la

motivación intrínseca en los individuos físicamente activos pueden promover un compromiso más amplio con un estilo de vida saludable, incluidas mejores elecciones alimentarias[154].

Los hombres con DM mostraron una mayor adherencia a las recomendaciones de AF en comparación con las mujeres, lo cual coincide con la literatura existente, que indica que los hombres participan de manera consistente en más AF moderada a vigorosa a lo largo de la vida[155]. Las barreras para la AF en las mujeres incluyen menor apoyo social y motivación y sentimiento de vergüenza, mientras que los hombres citan predominantemente la falta de tiempo como barrera[156].

Estrategias innovadoras, como las intervenciones administradas digitalmente, se utilizan cada vez más para reducir el comportamiento sedentario y promover la AF en adultos con DM[157,158]. Un metaanálisis reciente de ensayos controlados aleatorizados concluyó que estas intervenciones aumentaron la AF y redujeron el sedentarismo en adultos con DM tipo 2[157]. Sin embargo, otros metaanálisis mostraron que las intervenciones de salud digital aún no han demostrado beneficios sustanciales sobre la atención tradicional para el manejo de enfermedad crónicas, incluida la DM, en la atención primaria europea[158].

En España, se realizó un ensayo clínico controlado aleatorizado paralelo, simple ciego, de 12 semanas, con 123 participantes recientemente diagnosticados de DM tipo 2, para evaluar si el tratamiento conductual Greenhabit (salud móvil (mHealth)) mejora los resultados de la DM tipo 2 en comparación con la atención estándar. El estudio encontró que la AF aumentó significativamente después de la intervención[159]. Sin embargo, otro ensayo clínico aleatorizado realizado en España, con dos brazos con pacientes con DM tipo 2, para evaluar el impacto de DiabeText, una nueva intervención de salud móvil

basada en teoría, centrada en el paciente, integrada con historias clínicas, para enviar mensajes de textos cortos personalizados con el fin de apoyar el autocontrol de la DM tipo 2, concluyó que durante un periodo de 12 meses no se observaron mejoras estadísticamente significativas en la adherencia a la dieta mediterránea ni en la AF[160].

Estos enfoques digitales tienen potencial para superar las barreras tradicionales a la AF, por lo que las futuras estrategias de salud pública deberían incorporar dichas herramientas, junto con la educación personalizada, para optimizar los resultados en el cuidado de la DM.

Nuestros resultados refuerzan el valor de combinar el asesoramiento nutricional y la promoción de la AF dentro de un marco integrado para el manejo de DM. Los individuos que reportaron niveles moderados a altos de AF también mostraron una mejor adherencia a las recomendaciones dietéticas, lo que sugiere una relación sinérgica que podría aprovecharse en el diseño de intervenciones. Los programas de estilo de vida integrados que apuntan simultáneamente a la dieta y a la AF, han demostrado ser capaces de reducir la incidencia de DM y de mejorar el control glucémico, la composición corporal y los resultados cardiovasculares entre los pacientes con DM[161]. La evidencia económica también indica que estos programas son rentables[162–164].

Nuestros hallazgos resaltan la necesidad de programas escalables, sensibles al género y apropiados para la edad, que promuevan en paralelo tanto la calidad dietética como la AF[162,164].

9.3. Utilización de recursos sanitarios

La principal conclusión de este artículo fue el descenso significativo del porcentaje de participantes con visitas a urgencia y hospitalización en la población con DM de 2014 a 2020. Este resultado es similar a los resultados en otro estudio realizado en España, en

que se encontró un descenso en la tasa de hospitalización en individuos con DM de 2007 a 2015[165,166]. El mismo descenso también fue observado en un estudio poblacional realizado en Polonia[167]. En cambio, en un estudio llevado a cabo en Ghana se detectó un aumento en el porcentaje de hospitalización de 2012 a 2017[168].

Con respecto a las visitas a Urgencias, en la literatura está documentado un aumento de dicha prevalencia en otros países, como Estados Unidos y en Arabia Saudí[169,170]. Estas disparidades en la tendencia de la utilización de recursos sanitarios entre diferentes países podrían explicarse por diferencias en el acceso a los sistemas sanitarios, el nivel socioeconómico y las políticas sanitarias regionales[171].

El descenso en la utilización de servicios sanitarias observado entre 2014 y 2020 podría ser explicadas por mejoras en el manejo de la DM, como una mayor disponibilidad de especialista en Endocrinología[172]. No obstante, dado que nuestro estudio carece de datos sobre las causas de las hospitalizaciones y de visitas a Urgencias, se desconoce el factor causal de esta tendencia. Recientemente se ha aprobado en España la financiación pública de nuevos fármacos hipoglucemiantes no insulínicos. Aunque nuestro estudio no incluye datos sobre el tratamiento ni sobre el nivel de control glucémico, es plausible que la introducción de estas terapias haya contribuido a una mejor gestión de la enfermedad, reduciendo potencialmente las complicaciones y las visitas a Urgencias en los pacientes con DM[173]. Sin embargo, esto sigue siendo una hipótesis que no puede confirmarse con los datos actuales.

Durante la pandemia de COVID-19, las autoridades españolas implementaron medidas que limitaban la movilidad de la población[174]. Estas medidas, junto con el miedo de la población de contagiarse, sobre todo, las personas con diferentes grados de inmunosupresión, incluyendo a los pacientes diabéticos, conllevaron una menor

utilización de recursos sanitarios por causas diferentes del COVID-19[175]. Adicionalmente, durante este periodo, se suspendieron actividades asistenciales no urgentes, priorizando la atención de casos relacionado con el COVID-19[124]. Esta interrupción en la atención y el seguimiento rutinarios representa una limitación importante para la interpretación de nuestros resultados en el periodo 2020, ya que puede haber influido en la utilización de recursos sanitarios independientemente de las necesidades de salud subyacentes. En un estudio dirigido a analizar el impacto de medidas restrictivas del COVID-19, se observó un descenso en la HbA1c en la población con DM en comparación con los mismos periodos del año anterior[174]. Sin embargo, otros estudios han reportado hallazgos opuestos, mostrando un deterioro en el control glucémico en el contexto de una elevada inflamación sistémica causada por la infección por COVID-19. Por lo tanto, durante la pandemia, la tasa de infecciones pudo haber sido un factor que contribuyó a un peor control de la enfermedad en los individuos con DM[176,177].

En nuestro estudio, la tasa de hospitalización en la población con DM fue 1,6 veces mayor que en la población sin DM. Este hallazgo es concordante con lo descrito en la literatura[178,179]**.** El aumento observado de la prevalencia de hospitalización con la edad es similar al encontrado en un estudio realizado en Ghana en la población con DM[168], en el que se encontró una mayor prevalencia de hospitalización en el grupo de edad de 75 a 79 años frente al de 25 a 29 años.

En cuanto al sexo, en nuestro estudio se objetivó una mayor probabilidad de hospitalización en los hombres con DM. Existen varios estudios en la literatura que han analizado la tasa de hospitalización en los pacientes con DM en función del sexo. Sin embargo, los resultados son dispares, probablemente por el sesgo de género, diseño del

estudio y diferencias demográficas y sociales[180]. En varios estudios previos, se ha observado que las mujeres presentan una mayor mortalidad y un mayor riesgo de hospitalización por enfermedad cardiovascular[181,182].

Por otra parte, en nuestro estudio, se observó una asociación positiva entre DM y otras comorbilidades, tales como cardiopatía isquémica, ictus, cáncer, enfermedad mental, EPOC y dolor crónico. Estos hallazgos son similares a los descritos en un estudio de la literatura, en el que se observó una mayor prevalencia de hipertensión arterial, enfermedad renal crónica, enfermedad coronaria e insuficiencia cardíaca en la población con DM frente a aquella sin DM[178].

En un estudio de Shervin Assari et al., se observó una relación positiva entre la autopercepción desfavorable de la salud y una mayor utilización de recursos sanitarios, tanto de visitas a Urgencias como de hospitalización[183]. Este hallazgo es similar al observado en nuestro estudio. Estudios previos han identificado la autopercepción de la salud como un predictor de la mortalidad[184,185]. También se asocia de forma consistente con la multimorbilidad[186], un factor que contribuye a mayores números de visitas a Urgencias y hospitalizaciones.

En nuestro estudio, se encontró una asociación entre hospitalización y ser no fumador, aunque esta no fue estadísticamente significativa dentro del subgrupo de pacientes con DM. Una posible explicación es el efecto del “superviviente sano” o la causalidad inversa, mediante la cual los individuos pueden adoptar conductas más saludables, como dejar de fumar, después de una hospitalización o de complicaciones derivada de enfermedades crónicas[187]. De manera similar, se observó una asociación inversa entre dislipemia y hospitalización. Una posible explicación es que los individuos diagnosticados de dislipemia y DM suelen estar bajo una supervisión médica más

estricta y un seguimiento más regular[188]. Esto podría conducir a una mejor prevención de complicaciones agudas y, como resultado, a una menor probabilidad de hospitalización. Sin embargo, se necesitan más estudios para corroborar esta hipótesis.

En cuanto a las visitas a Urgencias, en nuestro estudio, se objetivó una mayor prevalencia de visitas a Urgencias en los participantes con DM en comparación con los participantes sin DM. Especialmente, esta prevalencia fue más elevada en las mujeres. Este hallazgo también fue descrito en un trabajo realizado por Tegveer S Uppal et al. [189]. Sin embargo, en un estudio prospectivo dirigido por Neeti Patel et. al., realizado en Estados Unidos, no se observaron diferencias en las visitas a Urgencias entre hombres y mujeres con DM [190].

Atendiendo a la presencia de comorbilidades, Loredana Santo et al. demostraron un aumento en la tasa de visitas a Urgencias a medida que aumentaban las comorbilidades[191]. Se detectó el mismo fenómeno en otro estudio realizado por Ming Ye et al.[192] Los resultados de nuestro estudio fueron concordantes con los publicados en la literatura. Especialmente, se vio una asociación entre enfermedad mental y visitas a Urgencias. Esto coincide con los resultados de los estudios realizados por Hutter et. al. y Shulman et al., que demostraron una mayor prevalencia de visitas a Urgencias, de hospitalización y un mayor coste sanitario en los sujetos con DM y enfermedad mental frente a aquellos con DM sin enfermedad mental[193,194].

En cuanto a los factores sociales, en un estudio realizado en México[195], el alto nivel educativo se identificó como un factor asociado a un mayor riesgo de visitas a Urgencias en la población con DM tipo 1. En nuestro estudio, al contrario, se observó una mayor prevalencia de visitas a Urgencias en los pacientes con DM con estudios primarios o sin

estudios. Esta diferencia se debe, probablemente, a la existencia de diferencias sociales y a que en nuestro estudio no se distingue entre DM tipo 1 y DM tipo 2.

Para reducir la utilización excesiva de recursos sanitarios en la población con DM, es de interés reforzar la atención primaria y especializada de estos individuos, prestando especial atención a aquellos que presenten otras comorbilidades, dado que presentan un mayor uso de estos recursos. Otras medidas podrían consistir en la detección y tratamiento precoz de DM y de las complicaciones microvasculares y macrovasculares derivadas, y fomentar la educación diabetológica en esta población, con el objetivo de reducir la prevalencia de visitas a Urgencias y hospitalización[196][197].

9.4. Fortalezas y limitaciones

Esta tesis presenta varias fortalezas. En primer lugar, el tamaño muestral es elevado, haciendo que la potencia estadística sea alta, permitiendo detectar diferencias pequeñas como significativas. En segundo lugar, la metodología de la encuesta es rigurosa y está validada, y su uniformidad permite la comparación de los datos provenientes de diferentes ediciones. En tercer lugar, el formato anónimo permite la obtención de datos más fiables. Finalmente, la EHISS recopila los datos sociodemográficos y de estilo de vida que, por lo general, no se encuentran registrados en las historias clínicas.

Esta tesis también presenta varias limitaciones. En primer lugar, una de las principales es la incapacidad de distinguir entre DM tipo 1 y tipo 2. Esta limitación es especialmente relevante en la interpretación de los resultados, dado que ambos tipos difieren en su etiología, tratamiento y complicaciones asociadas. En segundo lugar, carece de datos sobre el grado de control de la enfermedad. En tercer lugar, el diagnóstico de DM fue autorreportado por los participantes, sin verificación a través de registros médicos. Este

método puede suponer un sesgo de recuerdo y de deseabilidad social, que podrían comprometer la fiabilidad de la información proporcionada. Sin embargo, un estudio realizado en la población española ha mostrado una buena concordancia entre los diagnósticos autorreportados y la verificación mediante registros médicos[198]. En cuarto lugar, dado que las preguntas de la encuesta se refieren al pasado, puede ocurrir sesgo de memoria. En quinto lugar, deben considerarse las tasas de respuesta de las encuestas (74.6% en la edición 2014 y 72.2% 2020) y el potencial sesgo derivado de la no participación[199,200]. Finalmente, la diferencia en el modo de contacto para la realización de la entrevista, debido al impacto de la pandemia de COVID-19, podría afectar a la calidad de los datos recogidos por vía telefónica y a la comparabilidad de estos con los recogidos de forma presencial.

10. CONCLUSIONES

1. El nivel de adherencia a las pruebas de cribados, como la citología y la detección de sangre oculta en heces, aumentó de forma significativa entre 2014 y 2020.

2. La realización de mamografías y citologías fue menor en la población con diabetes mellitus en comparación con la población sin esta enfermedad.

3. Entre los factores predictores de la realización de mamografías se identificaron la edad, la convivencia con una pajera, el consumo moderado de alcohol y los antecedentes de cáncer. Por el contrario, el antecedente de DM se asoció con una menor participación en este programa de cribado. Un nivel educativo alto y la participación en la edición 2020 de la encuesta se relacionaron con una mayor adherencia al cribado de cáncer de cérvix. De igual forma, un nivel educativo alto, la edad avanzada, los antecedentes de cáncer y la participación en la edición 2020 de la encuesta se asociaron con una mayor adherencia al cribado de cáncer colorrectal.

4. Se observó una mayor adherencia a las recomendaciones nutricionales en los adultos con DM en comparación con aquellos sin esta enfermedad. Sin embargo, la adherencia a las recomendaciones de actividad física fue menor en los individuos con DM.

5. El género femenino, la edad avanzada y un alto nivel de actividad física se relacionaron con una mayor adherencia a las recomendaciones nutricionales en la población con DM.

6. Se observó un descenso significativo en la prevalencia de hospitalización y de visitas a Urgencias en la población con DM entre 2014 y 2020.

7. Se objetivó un mayor porcentaje de hospitalización y de visitas a urgencias en los participantes con DM en comparación con aquellos sin la enfermedad.

8. La percepción desfavorable del estado de salud, junto con la presencia de comorbilidades como isquemia cardíaca, ictus, cáncer, enfermedad mental, EPOC y

dolor crónico, se asociaron con una mayor probabilidad de hospitalización y de visitas a Urgencias.

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12. Anexo

Los criterios diagnósticos de prediabetes en individuos no gestantes fueron los siguientes:

- HbA1c entre 5,7% y 6,4%;
- Glucosa plasmática en ayunas de 100 mg/dL a 125 mg/dL;
- Glucosa plasmática 2 horas después de la sobrecarga oral de 75 g de glucosa entre 140 mg/dL y 199 mg/dL.

Tabla 1. Criterios diagnósticos de diabetes gestacional.

Característica	**Prueba de 1 paso (SOG 75 g)**	**Prueba de 2 pasos**
Población	Todas las mujeres entre 24 y 28 semanas de gestación	Todas las mujeres entre 24 y 28 semanas de gestación
Primer paso	N/A	Glucosa 50 g, 1 hora, no en ayuno
Valor positivo primer paso	N/A	Si glucemia ≥ 130 – 140 mg/dL, se realiza SOG 100 g
Segundo paso	SOG 75 g: ayuno, 1 hora, 2 horas	SOG 100 g: ayuno, 1 hora, 2 horas, 3 horas
Criterio diagnóstico	Cualquiera de los valores: ayuno ≥ 92 mg/dL, 1 hora ≥ 180 mg/dL, 2 horas ≥ 153 mg/dL	≥ 2 valores elevados: ayuno ≥ 95 mg/dL, 1 hora ≥ 180 mg/dL, 2 horas ≥ 155 mg/dL, 3 horas ≥140 mg/dL

SOG: sobrecarga oral de glucosa; N/A: no aplicable.

Las guías de la ADA establecen los siguientes criterios para el diagnóstico de CAD:

- Hiperglucemia > 200 mg/dL o antecedente de DM;
- pH < 7,3 o bicarbonato < 18 mmol/L;
- Concentración de beta-hidroxibutirato ≥ 3 mmol/L o cetonuria ≥ 2+.

Los criterios diagnósticos del EHH fueron:

- Glucemia plasmática ≥ 600 mg/dL;
- Hiperosmolaridad > 300 mOsm/kg;
- Ausencia de cetonemia (beta-hidroxibutirato < 3 mmol/L o cetonuria < 2+);
- Ausencia de acidosis (pH ≥ 7,3 y bicarbonato > 15 mmol/L).