UNIVERSITAT DE BARCELONA

Evolución de la atención a la Diabetes tipo 2 en Catalunya 1993-2013

Manuel Mata Cases

UNIVERSITAT DE BARCELONA

Universitat de Barcelona. Programa de Doctorat en Medicina

Tesis Doctoral
Manel Mata Cases

Evolución de la atención a la Diabetes tipo 2 en Catalunya 1993-2013

Barcelona, enero 2017

Portada: Multitud. Pintura de André Langer Fernández (Chile, 1978)

UNIVERSITAT DE BARCELONA

Tesis Doctoral
Evolución de la atención a la Diabetes tipo 2 en Catalunya 1993-2013

Autor:
Manel Mata Cases

Centre d'Atenció Primària La Mina. Sant Adrià de Besòs (Barcelona). Gerència d'Àmbit d'Atenció Primària Barcelona Ciutat. Institut Català de la Salut.

Grup DAP_CAT (Grup de Recerca Epidemiològica en Diabetis des de l'Atenció Primària a Catalunya) de la Unitat de Suport a la Recerca de Barcelona de l' Institut Universitari d'Investigació en Atenció Primària Jordi Gol (IDIAP-Jordi Gol).

Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut (GEDAPS) de la Societat Catalana de Medicina Familiar i Comunitària (CAMFIC). Red de Grupos de Estudio de la Diabetes en Atención Primaria de Salud España (RedGDPS).

Centro de Investigación Biomédica en Red de Diabetes y Enfermedades Metabólicas Asociadas (CIBERDEM), Instituto de Salud Carlos III (ISCIII).

Directores:
Dr. Josep Franch Nadal

Centre d'Atenció Primària Raval Sud. Barcelona
Departament de Medicina
Universitat de Barcelona

Dra. Anna Novials Sardà

Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS). Barcelona
Departament de Medicina
Universitat de Barcelona

Es de importancia para quien desee alcanzar una certeza en su investigación, el saber dudar a tiempo.

Aristóteles

Agradecimientos

Esta tesis es el resultado de un gran esfuerzo, de muchas horas de dedicación y de más de 20 años de trabajo. Gracias a todas aquellas personas que habéis formado parte de este proyecto tanto los miembros del grupo GEDAPS como del DAP_CAT, y en especial, a Josep Franch y Anna Novials, por haberlo dirigido, sin vosotros no hubiera sido posible. Quedan atrás casi 25 años desde que Paco Cano nos convocó para constituir el GEDAPS y desde entonces hemos trabajado juntos en numerosos proyectos. Al Consell Assessor de la Diabetis y especialmente a Gonçal Lloveras y Conxa Castells que desde el principio han apoyado al grupo y sus iniciativas. A Dídac Mauricio, Josep Franch y Jordi Real por las horas que hemos compartido en este proyecto y por su amistad. A Boni Bolíbar, Xavier Mundet, Miguel Angel Muñoz y los otros miembros de la USR de Barcelona Ciutat y de la IDIAP-Jordi Gol, por facilitarme tanto el acceso a los datos, como mi liberación, mediante una beca de intensificación, para el anàlisis y redacción de esta tesis. A todos os debo el haber llegado hasta aquí.

A mis compañeros y amigos del CAP La Mina, y especialmente a Isabel Bobé y los residentes que me han tenido como tutor, por tanto años de compartir pasión por la profesión y específicamente por la diabetes, por vuestro día a día, por vuestro trabajo, amistad y apoyo desde hace más de 30 años.

Finalmente quiero agradecer a mi familia todo lo que soy y lo que he conseguido. Por vuestro apoyo incondicional y el profundo amor que nos une y muy especialmente a Marifé, Laura y Marc que han sido mi motor de superación durante todos estos años. Sin vosotros nada tendría el sentido que tiene. A Marifé, mi compañera de viaje, por este increíble camino que hemos recorrido juntos y por el que nos queda por compartir. Gracias por todo lo que me has dado y por hacerme tan feliz. A todos vosotros os dedico esta tesis, y todo el esfuerzo que ha comportado conseguirla, puesto que, junto a mi profesión, sois mi razón de ser.

Gracias a todos.

INDICE

Resumen

La diabetes mellitus tipo 2 (DM2) afecta a un 13,8% de las personas adultas en España, aunque sólo están diagnosticados algo más de la mitad (un 56,6% de los afectados). La DM2 muy frecuentemente se asocia a otros factores de riesgo como la obesidad, la hipertensión o la dislipemia, lo que confiere a los pacientes un elevado riesgo cardiovascular. Para intentar reducir la mortalidad y minimizar el impacto de las complicaciones de la enfermedad diabética (cardiovasculares, retinopatía, nefropatía y neuropatía), es necesaria la implicación de los profesionales, así como la responsabilización del paciente para conseguir y mantener un adecuado control de la glucemia y del resto de factores de riesgo cardiovascular. Así mismo los profesionales y el conjunto del sistema sanitario deben ofrecer un manejo clínico de calidad a toda la población a su cargo.

En 1993 se inició el programa de Mejora Continua de la Calidad (MCC) de la atención a la diabetes tipo 2 en Cataluña a partir de las evaluaciones periódicas realizadas por el grupo GEDAPS (Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut). Desde entonces, el grupo ha elaborado guías con recomendaciones clinicas y organizativas y ha impulsado actividades de formación continuada destinadas a mejorar la calidad asistencial. Desde la primera evaluación realizada en 1993 se ha ido observando una progresiva mejora en la mayor parte de los indicadores, no sólo del proceso asistencial sino también de los resultados intermedios (control glucémico, de la presión arterial y de los niveles de colesterol en sangre) y finales, con reducciones en la prevalencia de algunas complicaciones como la retinopatía, las úlceras y las amputaciones.

La última evaluación del GEDAPS se realizó en 2007. Posteriormente, el grupo DAP_CAT (Grup de Recerca Epidemiològica en Diabetis des de l'Atenció Primària a Catalunya) ha analizado los datos registrados de la base de datos

SIDIAP (Sistema d'Informació per el Desenvolupament de la Investigació en Atenció Primària) que incluye toda la población atendida por el Institut Català de la Salut. La comparación de los datos de 2007 a 2013 ha mostrado un aumento considerable de la prevalencia de diabetes registrada y una progresiva mejora del control de las cifras de presión arterial y de los niveles de colesterol, manteniéndose estable el control glucémico a pesar de que se ha intensificado progresivamente el tratamiento con fármacos antidiabéticos. En esta tesis doctoral se analizan y comparan los datos de las evaluaciones disponibles entre 1993 y 2013 a partir de las principales publicaciones en las que ha participado el doctorando.

Abstract

Type 2 Diabetes mellitus (T2DM) affects 13.8% of adults in Spain, although they are only diagnosed just over half (56.6% of those affected). DM2 is usually associated with other risk factors such as obesity, hypertension or dyslipidemia, giving patients a high cardiovascular risk. To try to reduce mortality and minimize the impact of the complications of the disease (cardiovascular disease, retinopathy, nephropathy and neuropathy), it is necessary the involvement of professionals and the participation of the patient to achieve and maintain an adequate control of glycemia and other cardiovascular risk factors. Likewise professionals and the entire health system should provide a good quality clinical management covering the entire population.

In 1993, the GEDAPS (Group for the Study of Diabetes in Primary Care) Continuous Quality Improvement of care for type 2 diabetes program in Catalonia began and promoted periodic evaluations. The GEDAPS group has developed guidelines with clinical and organizative recommendations and has driven continuous educational activities aimed to improve the quality of care. Since the first evaluation in 1993 a gradual improvement in most of the indicators has been observed, not only the process of care but also the intermediate results (glycemic control, blood pressure and blood cholesterol levels) and final outcomes, with reductions in the prevalence of some complications such as retinopathy, ulcers and amputations.

The last GEDAPS evaluation was conducted in 2007. Subsequently, the DAP_CAT group (Diabetes Research Group in Primary Care_Catalunya) has analyzed the data recorded in the data base SIDIAP (Information System for the Development of Research in Primary Care) including all the population cared for by the Institut Català de la Salut. Comparing data from 2007 to 2013 has shown a significant increase in the prevalence of registered diabetes and a gradual improvement in the control of blood pressure and blood cholesterol, remaining estable the glycemic control although antidiabetic treatment has been gradually

intensified. This thesis analyzes and compares the available data from the evaluations between 1993 and 2013 from the major publications in which the doctoral candidate has participated.

Acrónimos

Colesterol LDL	Colesterol unido a lipoproteínas de baja densidad (Low Density Lipoproteins)
Colesterol HDL	Colesterol unido a lipoproteínas de alta densidad (High Density Lipoproteins)
DAP_CAT	Grup de Recerca Epidemiològica en Diabetis des de l'Atenció Primària a Catalunya
di@bet.es	Estudio de la prevalencia de la diabetes en España
DM	Diabetes Mellitus
DM1	Diabetes Mellitus tipo 1
DM2	Diabetes Mellitus tipo 2
DPP4	Dipeptidil Peptidasa 4
EAP	Equipo de Atención Primaria
e-CAP	Estació Clínica d'Atenció Primària
GLP-1	Glucagón Like Peptide-1 (Péptido similar al Glucagón-1)
HbA1c	Hemoglobina glicosilada A1c
ICS	Institut Català de la Salut
IDIAP-Jordi Gol	Institut d'Investigació en Atenció Primària Jordi Gol
IMC	Indice de Masa Corporal
GEDAPS	Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut
JDS/JSCC	Japan Diabetes Society/Japan Society for Clinical Chemistry
MDRD	Modification of Diet in Renal Disease
NGSP/DCCT	National Glycohemoglobin Standardization Program/ Diabetes Control and Complications Trial
PA	Presión Arterial
RedGDPS	Red Española de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud
Red MCC-GEDAPS	Red de Mejora Continua de la Calidad-GEDAPS
SIDIAP	Sistema d'Informació per el Desenvolupament de la Investigació en Atenció Primària
SISAP	Sistema d'Informació dels Serveis d'Atenció Primària
UKPDS	United Kingdom Prospective Diabetes Study

1. Presentación

Esta tesis doctoral se estructura según la normativa de la Universitat de Barcelona para la presentación de Tesis Doctorales en el formato de compendio de artículos.

Los artículos incluidos forman parte de una línea de investigación iniciada en el año 1993 y dirigida a conocer y monitorizar la evolución de la calidad de la atención a la DM2 en Catalunya. Los resultados obtenidos han aportado información relevante en este campo y han sido publicados en varios artículos en revistas científicas de impacto internacional. Para esta tesis se han seleccionados cinco artículos ya publicados sobre la evolución del manejo y el grado de control de la DM2 en Catalunya. Un sexto artículo sobre la evolución de la mortalidad, las complicaciones cardiovasculares y el grado de control de los factores de riesgo cardiovascular, y un séptimo artículo sobre la prevalencia y factores pronósticos de la enfermedad renal crónica, están en fase de redacción.

Título: Fifteen years of continuous improvement of quality care of type 2 diabetes mellitus in primary care in Catalonia, Spain

Autores: **Mata-Cases M,** Roura-Olmeda P, Berengué-Iglesias M, Birulés-Pons M, Mundet-Tuduri X, Franch-Nadal J, Benito-Badorrey B, Cano-Pérez JF on behalf of the Diabetes Study Group in Primary Health Care (GEDAPS: Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut, Catalonian Society of Family and Community Medicine)

Revista: Int J Clin Pract. 2012; 66 (3): 289–98.

Factor de impacto: 2,427 (Cuartil 1)

Título: Control of glycemia and cardiovascular risk factors in patients with type 2 diabetes in primary care in Catalonia (Spain).

Autores: Vinagre I, **Mata-Cases M,** Hermosilla E, Morros R, Fina F, Rosell M, Castell C, Franch-Nadal J, Bolíbar B, Mauricio D.

Revista: Diabetes Care 2012; 35:774-9. doi: 10.2337/dc11-1679. Epub 2012 Feb 16.

Factor de impacto: 7,735 (Cuartil 1)

Título: Differences in the Cardiometabolic Control in Type 2 Diabetes According to Gender and the Presence of Cardiovascular Disease: Results from the eControl Study.

Autores: Franch-Nadal J, **Mata-Cases M,** Vinagre I, Patitucci F, Hermosilla E, Casellas A, Bolivar B, Mauricio D.

Revista: Int J Endocrinol. 2014; 2014:131709. doi: 10.1155/2014/131709. Epub 2014 Sep 21

Factor de impacto: 1,948 (Cuartil 2)

Título: Metabolic control and cardiovascular risk factors in type 2 diabetes mellitus patients according to diabetes duration

Autores: Franch-Nadal J, Roura-Olmeda P, Benito-Badorrey B, Rodríguez-Poncelas A, Coll-de-Tuero G; **Mata-Cases M**, on behalf of the GedapS (Primary care Group for the study of Diabetes).

Revista: Fam Pract. 2015; 32(1):27-34. doi: 10.1093/fampra/cmu048. Epub 2014 Sep 5.

Factor de impacto: 2,022 (Cuartil 1)

Título: Glycemic Control and Antidiabetic Treatment Trends in Primary Care Centers in Patients with Type 2 Diabetes During 2007-2013 in Catalonia: a Population-Based study

Autores: **Mata-Cases M**, Franch-Nadal, Real J, Mauricio D.

Revista: BMJ Open 2016, doi:10.1136/bmjopen-2016-012463 [Epub ahead of print]

Factor de impacto: 2,562 (Cuartil 1)

El impacto conjunto estimado de las cinco publicaciones es de 14,132.

Como información adicional, mencionar que el doctorando también es autor de los siguientes artículos centrados en la atención a la DM2 en Catalunya:

1. Mundet X, Cano F, **Mata-Cases M,** Roura P, Franch J, Birules M, et al. Trends in chronic complications of type 2 diabetic patients from Spanish primary health care centres (GEDAPS study): Ten year-implementation of St. Vincent recommendations. Prim Care Diabetes. 2012;6(1):11–8. Factor de impacto: 1,609 (Cuartil 2)
2. Coll-de-Tuero G, **Mata-Cases M**, Rodriguez-Poncelas A, Pepió JM, Roura P, Benito B, Franch-Nadal J, Saez M. Chronic kidney disease in the type 2 diabetic patients: prevalence and associated variables in a random sample of 2642 patients of a Mediterranean area. BMC Nephrol. 2012 Aug 20; 13(1):87. [Epub ahead of print]. Factor de impacto: 2,470 (Cuartil 1)
3. **Mata-Cases M,** Benito-Badorrey B, Roura-Olmeda P, Franch-Nadal J, Pepió-Vilaubí JM, Saez M, Coll-de-Tuero G; on behalf of the GEDAPS (Primary Care Group for the study of Diabetes) of the Catalonian Society of Family and Community Medicine. Clinical inertia in the treatment of hyperglycemia in type 2 diabetes patients in primary care. Curr Med Res Opin. 2013; 29(11): 1495-502. Epub 2013 Sep 6. Factor de impacto: 2,370 (Cuartil 1)
4. Bodicoat DH, Mundet X, Davies MJ, Khunti K, Roura P, Franch J, **Mata-Cases M,** Cos X, Cano JF; on behalf of the GEDAPS Study Group. The impact of a programme to improve quality of care for people with type 2 diabetes on hard to reach groups: The GEDAPS study. Prim Care Diabetes. 2015 Jun;9(3):211-8. doi: 10.1016/j.pcd.2014.08.001. Epub 2014 Sep 1. Factor de impacto: 1,570 (Cuartil 2)
5. **Mata-Cases M**, Mauricio D, Vinagre I, Morros R, Hermosilla E, et al. Treatment of Hyperglycaemia in Type 2 Diabetic Patients in a Primary Care Population Database in a Mediterranean Area (Catalonia, Spain). J Diabetes Metab 2014. 5: 338. doi:10.4172/2155-6156.1000338 Factor de impacto: No
6. Rodriguez-Poncelas A, Miravet-Jimenez S, Casellas A, Franch J, Lopez-Simarro F, **Mata-Cases M,** Mundet X. Prevalence of diabetic retinopathy in patients with Type 2 diabetes who had recorded diabetic retinopathy from retinal photographs in Catalonia (Spain). Br J Ophthalmol. 2015; 99(12):1628-33. doi:10.1136/bjophthalmol-2015-306683. Epub 2015 Jun 18. Factor de impacto: 3,036 (Cuartil 1)
7. Barrot-de la Puente J, **Mata-Cases M**, Franch-Nadal J, Mundet-Tudurí X, Casellas A, Fernandez-Real JM, Mauricio D. Older type 2 diabetic patients are more likely to achieve glycemic and cardiovascular risk factors targets than younger patients: analysis of a primary care database. Int J Clin Pract. 2015;69(12):1486-95.doi:10.1111/ijcp.12741.Epub 2015 Sep 30. Factor de impacto: 2,226 (Cuartil 1)
8. Ruiz-Tamayo I, Franch-Nadal J, **Mata-Cases M,** Mauricio D, Cos X, Rodriguez-Poncelas A, Barrot J, Coll-de-Tuero G, Mundet-Tudurí X. Noninsulin Antidiabetic Drugs for Patients with Type 2 Diabetes Mellitus: Are We Respecting Their Contraindications?. J Diabetes Res. 2016; 2016:7502489. doi: 10.1155/2016/7502489. Epub 2016 Jan 6. Factor de impacto: 2,431 (Cuartil 2)
9. **Mata-Cases M,** Mauricio D, Franch-Nadal J. Clinical characteristics of type 2 diabetic patients on basal insulin therapy with adequate fasting glucose control that do not achieve glycated hemoglobin targets. J Diabetes. 2016 Jan 8. doi:10.1111/1753-0407.12373.[Epub ahead of print] Factor de impacto: 2,500 (Cuartil 2)

10. **Mata-Cases M,** Mauricio D, Real J, Bolíbar B, Franch-Nadal J. Is Diabetes Mellitus Correctly Registered and Classified in Primary Care? A Population-based Study in Catalonia, Spain. Endocrinol Nutr. 2016 Nov;63(9):440-448. doi: 10.1016/j.endonu.2016.07.004. Epub 2016 Sep 6. Factor de impacto: 1,314 (Cuartil 3)
11. **Mata-Cases M,** Casajuana M, Franch-Nadal J, Casellas A, Castell C, Vinagre I, Mauricio D, Bolíbar B. Direct medical costs attributable to type 2 diabetes mellitus: a population-based study in Catalonia, Spain. Eur J Heal Econ. 2016;17(8):1001–1010. Factor de impacto: 2,266 (Cuartil 1)

El impacto conjunto estimado de las dieciseis publicaciones sobre la atención a la DM2 en Catalunya es de 38,286

El doctorando (ORCID ID: 0000-0003-3693-3622) es autor de 50 artículos científicos referenciados en PubMed y/o Google Académico, todos ellos originales en revistas revisadas por pares, yendo de primer firmante en 22 de ellos y siendo 17 publicados en revistas de primer cuartil (SJR). Los factores de impacto oscilan entre el 0,3 de la revista Atención Primaria y el 8,9 de Diabetes Care. El índice H de citaciones según Scopus es de 9, incluyendo 46 articulos que han recibido 340 citaciones. En Google Académico, el índice H global es de 11 (454 citaciones) y, contando solo desde el año 2011, de 9 (391 citaciones).

El doctorando ha recibido una beca de intensificación de la actividad investigadora del 25% durante los años 2015 y 2016, de la IDIAP Jordi Gol y el Institut Català de la Salut, para la realización de la tesis doctoral (resolución 24/4/2015).

Las evaluaciones GEDAPS recibieron financiación parcial sin condiciones por parte de Bayer, MSD, Novonordisk, GSK y la Fundació d'Atenció Primària. El proyecto contó con el soporte y aprobación del Consell Assessor sobre la Diabetis a Catalunya del Departament de Sanitat de la Generalitat de Catalunya.

El proyecto de análisis de los datos de control glucémico y de los factores de riesgo y morbimortalidad cardiovascular del período 2007-2013 (SIDIAP) ha recibido financiación parcial sin condiciones por parte de AstraZéneca y MSD. El proyecto fue aprobado por el Comité Ètic d'Investigació Clínica de la IDIAP Jordi Gol con fecha 24/7/2013 con el código P13/073

2. Introducción

2.1. La atención a la diabetes: un desafío para los sistemas sanitarios

La diabetes mellitus tipo 2 (DM2) es una enfermedad metabólica crónica muy frecuente en los países desarrollados cuya prevalencia está adquiriendo proporciones de carácter epidémico en los países en vías de desarrollo, lo que se atribuye al envejecimiento de la población y a la prevalencia cada vez mayor de obesidad y sedentarismo en la población general [1]. En un reciente estudio poblacional (di@bet.es) realizado en España mediante la prueba de la sobrecarga oral de glucosa, se observó una prevalencia de DM2 del 13,8% en la población mayor de 18 años, con un 43,5% de casos no conocidos (prevalencia de diabetes conocida 7,8% y de diabetes ignorada del 6%) [2].

Las personas con DM2 tienen una mayor mortalidad total y de causa cardiovascular y un riesgo incrementado de presentar complicaciones microvasculares (retinopatía, nefropatía y neuropatía) y macrovasculares, como la cardiopatía isquémica, el accidente vascular cerebral (AVC) o la enfermedad arterial periférica [3–6]. Estas complicaciones crónicas empeoran la calidad de vida del paciente con DM2 [7] y comportan un gran incremento de los coste sanitarios [8–14]. Actualmente, se estima que la diabetes representa aproximadamente el 10% del gasto sanitario global de los países desarrollados, entre ellos España [11,14,15]. En un estudio reciente publicado por nuestro grupo, los pacientes con DM2 presentaron un incremento del coste de aproximadamente un 72% respecto de los usuarios sin diabetes de la misma edad y sexo atendidos en la atención primaria de Catalunya [16]. Además la presencia de complicaciones cardiovasculares aumentó 1,42 veces el coste anual y la insuficiencia renal terminal 10,35 veces [16]. Todo ello ha llevado a que se hayan promovido acciones a nivel internacional [5] y programas específicos a nivel estatal en España [17]. En Catalunya, la creación del Consell Assessor sobre la Diabetis en 1983 [18] ha contribuido a que se incluyera la diabetes en los Planes de Salud del Departament de Salut de la Generalitat de Catalunya [19]. Los principales objetivos de Consell Assessor son promover la investigación

epidemiológica, la educación y la colaboración entre asociaciones de pacientes, sociedades científicas y la administración, así como el patrocinio actividades formativas, elaboración de protocolos clínicos, documentos de consenso sobre pautas de actuación y sobre organización sanitaria [18].

La relación entre el control glucémico y las complicaciones crónicas de la diabetes está ampliamente demostrada [3,20,21], y en diferentes ensayos clínicos se han conseguido reducciones de las complicaciones microvasculares [22–24], los eventos cardiovasculares [25–28] o incluso la mortalidad [26,29–31] con diferentes estrategias relacionadas con el grado de control glucémico o el uso de grupos farmacológicos específicos. Los parámetros modificables que más importancia tienen para prevenir las complicaciones son el control de la glucemia (medido por el nivel de la Hemoglobina glucosilada A1c -HbA1c-), la presión arterial (PA), los lípidos (colesterol-LDL), el tabaquismo y la obesidad [21,32]. Las sociedades científicas han establecido recomendaciones y objetivos de control de todos estos factores de riesgo cardiovascular para reducir el impacto de la enfermedad [33–40]. Actualmente, en las guías del Institut Català de la Salut (ICS) se recomienda como objetivos de control para la mayoría de pacientes una HbA1c ≤7%, una PA <140/90 mmHg, un colesterol-LDL <100 mg/dl (en prevención secundaria) o <130 mg/dl (en prevención primaria), no fumar y un IMC <30 kg/m^2 [35], aunque siempre hay que individualizarlos en función de las características del paciente, especialmente la edad y la esperanza de vida, la presencia de complicaciones y el riesgo de efectos adversos del tratamiento [33–40].

En Cataluña, el grupo GEDAPS (Grup d'Estudi de la Diabetis en l'Atenció Primària de Salut) puso en marcha en el año 1993 el programa de mejora continua de la calidad GEDAPS (MCC-GEDAPS), basado en evaluaciones periódicas de estos indicadores y en la introducción de intervenciones orientadas a mejorar la calidad de la asistencia prestada a las personas con DM2 atendidas desde la Atención Primaria. La publicación por el mismo grupo de diferentes guías de práctica clínica y algoritmos de tratamiento ha sido también clave para establecer el liderazgo del grupo en el manejo de la DM2 en atención primaria [33,34,37,41]. Los resultados del programa de MCC han generado

numerosas publicaciones [42–50], disponiéndose de datos de sucesivas evaluaciones realizadas en 1993, 1995, 1997, 2000, 2002 y 2007.

Con posterioridad, el grupo DAP_Cat (Grup de Recerca Epidemiològica en Diabetis des de l'Atenció Primària a Catalunya), del que forman parte también varios miembros del GEDAPS, ha puesto en marcha estudios a partir de los datos poblacionales de la base de datos SIDIAP (Sistema de Información para el Desarrollo de la Investigación en atención Primaria) [51,52]. En este sentido, el estudio publicado en la revista Diabetes Care [53] sobre un total de casi 300.000 personas con DM2 atendidas durante el año 2009 por el ICS en Cataluña, ha constituido un hito en el conocimiento de la atención a la diabetes en el mundo real. A partir de los datos del SIDIAP se analizó el grado de control de la glucemia y de los otros factores de riesgo cardiovascular y la prevalencia de las complicaciones de la diabetes [53]. Además, permitió conocer el uso de los fármacos empleados en su control, tanto los fármacos antidiabéticos [54–56] como los fármacos para el resto de factores de riesgo [53,57]. Posteriores publicaciones han analizado más específicamente las diferencias en el grado de control por género [57], grupos de edad [58] o escalones terapéuticos [59], la prevalencia y características de la retinopatía y la nefropatía [60,61], así como los costes sanitarios directos atribuibles a la diabetes [16] o la validación del diagnóstico de la diabetes [62]. Finalmente, y con motivo de esta tesis doctoral, se ha analizado la atención a la DM2 entre 2007 y 2013 mediante cortes transversales anuales [59]. La cantidad y la calidad de la información que ofrece esta base de datos confieren una gran potencia y relevancia a cualquier análisis que se realice a partir de ella [51,52].

2.2. La atención primaria como eje central de la atención a la DM2

En nuestro país, y en la mayor parte de los sistemas de salud europeos, los pacientes con DM2 tienen como referentes básicos de su atención a los profesionales del Equipo de Atención Primaria (EAP), que son los que gestionan y atienden este problema de salud de manera integral e integrada [63].

En general, sólo cuando el paciente presenta complicaciones avanzadas o una elevada complejidad en el tratamiento es necesario derivarlo a los servicios de referencia de endocrinología, u otros servicios hospitalarios, que intervendrán o darán apoyo en el manejo de la enfermedad y sus complicaciones. El sistema sanitario debe garantizar la calidad y la continuidad asistencial para dar la respuesta más adecuada a cada paciente y en cada momento.

Existe en Catalunya una larga tradición de colaboración en el terreno asistencial entre los profesionales de la atención primaria y los que trabajan en la atención hospitalaria, especialmente con los profesionales de los servicios de endocrinología y nutrición [18]. Desde finales de los años 90 se empezaron a establecer los modelos de consultoría en diferentes territorios, que posteriormente se fueron desarrollando e implantando teniendo en cuenta las particularidades de cada entorno. Cabe destacar las “consultorías presenciales de endocrinología” y las experiencias más recientes de “consultoría virtual” como instrumentos de apoyo en la toma de decisiones [64,65]. Gracias a todas estas experiencias y otras similares que existen a lo largo del territorio de Cataluña, se evita la duplicidad de pruebas, permite la transferencia del conocimiento de unos a otros, evita desplazamientos innecesarios a los enfermos, y reduce considerablemente la lista de espera de los especialistas hospitalarios [65]. Todo ello dentro de los objetivos del Plan de Salud 2011-2105 [19], que prevé un sistema integrado más resolutivo desde los primeros niveles de la asistencia, en todo el territorio.

En general, hay que decir que desde la reforma de la atención primaria en los años 80 se ha incrementado notablemente las competencias de los profesionales y la capacidad de resolución de la atención primaria. A destacar especialmente el papel imprescindible de las enfermeras en la educación y capacitación de los pacientes en el manejo de su enfermedad, y también en la gestión global de los problemas de los pacientes. También los servicios de atención especializada endocrinológica de nuestro país han sido pioneros en el establecimiento de modelos organizativos (coordinación con atención primaria, hospitales de día, unidades del pie diabético), en la asistencia y en la

investigación. Todo ello ha contribuido a mejorar la calidad de la atención a la diabetes en Catalunya y consecuentemente reducir el impacto de la enfermedad en la calidad de vida de nuestros pacientes.

La constitución en el conjunto del estado español de la Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud (inicialmente RedGEDAPS, y más recientemente RedGDPS), de la que fue promotor inicial el grupo GEDAPS, ha llevado a los médicos y enfermeras del grupo a liderar la atención a la DM2 en atención primaria. A nivel estatal, miembros del grupo han liderado grupos de trabajo y participado en numerosos documentos de consenso y guías, son miembros de la junta directiva de la Sociedad Española de Diabetes (SED)[66], pero también lideran iniciativas ministeriales, como la Estrategia en Diabetes del Sistema Nacional de Salud [17] e incluso a nivel europeo en cargos directivos en el Primary Care Diabetes Europe [67]. En el caso concreto de Catalunya, los miembros del grupo GEDAPS han participado, entre otros, en la junta directiva de la Associació Catalana de Diabetis (ACD) [68] y el Consell Assessor de la Diabetis a Catalunya [18]. Actualmente, la página web de la RedGDPS (http://www.redgdps.org) y el blog del grupo (http://redgedaps.blogspot.com.es) constituyen un referente científico, no solo para los profesionales de atención primaria sino también de otras especialidades y profesiones sanitarias, tanto en España como en Latinoamérica.

2.3. Período 1993-2007: El Programa de Mejora Continua de la Calidad GEDAPS

La atención a la DM2 requiere no sólo la aplicación de medidas terapéuticas de probada eficacia, sino también de procedimientos clínicos correctos, una actitud estricta en relación a los objetivos del control por parte de los profesionales sanitarios, la mejora de los aspectos organizativos de la atención (protocolos, sistemas de registro, trabajo en equipo) y la adecuada coordinación entre los diferentes niveles asistenciales del sistema sanitario. En

consonancia con la Declaración de Saint Vincent [5], en el año 1993 se constituyó en el seno de la Sociedad Catalana de Medicina Familiar y Comunitaria, el grupo GEDAPS, compuesto mayoritariamente por médicos y enfermeras de la Atención Primaria, con los objetivos de:

- Mejorar el grado de control de las personas con DM2 en la Atención Primaria.
- Promover la formación continuada y la investigación sobre la DM2 en Atención Primaria.
- Promover acciones de mejora continua de la calidad de la atención a las personas con DM2 en Atención Primaria.
- Facilitar la evaluación interna y externa de la atención al diabético en los EAP de la red de MCC-GEDAPS y su comparación con el conjunto de su región sanitaria y de Cataluña mediante un programa informático diseñado específicamente para la realización de evaluaciones periódicas.

Para el logro de estos objetivos se desarrollaron una serie de iniciativas y estrategias como la guía GEDAPS de la DM2 [33,34], el programa informático de la Red de MCC-GEDAPS [69] y numerosas actividades de formación continuada de manera programada entre 1993 y 2002 por todo el territorio de Catalunya [43,44]. Con posterioridad y hasta la actualidad el grupo ha seguido realizando actividades formativas periódicas, pero sin formar parte de un plan específico de mejora de la calidad asistencial.

La primera iniciativa del grupo fue la edición y distribución a todos los profesionales de los EAP de la “Guía para el tratamiento de la diabetes tipo 2 en la Atención Primaria” que, desde la primera edición en 1993 [33], ha contado con el apoyo incondicional del Consell Assessor de la Diabetis de Catalunya. Posteriormente se publicaron nuevas ediciones en 1995, 2000, 2005 y 2011 [34]. La Guía contiene recomendaciones clínicas y organizativas para homogeneizar la atención al paciente diabético en Atención Primaria y propiciar un enfoque integral a un paciente de riesgo multifactorial que requiere un abordaje global, por lo que las intervenciones sobre el tabaquismo, la presión arterial, la

dislipemia y la hiperglucemia deben tener la misma prioridad. Posteriormente, la Guía del ICS [35], en que han participado también algunos médicos y enfermeras del GEDAPS, ha recogido prácticamente la mayor parte de los contenidos y las recomendaciones promovidas en las últimas ediciones de la guía GEDAPS [34].

El mismo año 1993 el GEDAPS puso en marcha el programa MCC-GEDAPS basado en las propuestas de la Declaración de Saint Vincent [5] con la definición de unos indicadores de proceso y de resultados intermedios y finales, para monitorizar y promover actividades de mejora continua de la calidad de la atención a la población diabética [69]. También se hicieron unas recomendaciones organizativas con el fin de mejorar la implementación de las actividades asistenciales de realización periódica (seguimiento clínico y detección de complicaciones) y su registro en una hoja de monitorización, y que fueron actualizadas en las diferentes ediciones de la guía GEDAPS. Al mismo tiempo se diseñó un programa informático de distribución gratuita para la recogida de datos [69] que ofrecía a los centros participantes en la Red MCC-GEDAPS la posibilidad de disponer inmediatamente de los resultados de los indicadores de calidad de su centro y posteriormente, con la agregación de los datos de todos los centros, conocer los datos de su área geográfica y del conjunto de Cataluña. La participación de los centros era voluntaria e implicaba únicamente que la persona responsable de la revisión de las historias clínicas tenía un interés por la mejora de la calidad de la atención a la DM2 y que con la presentación de los resultados a su EAP se fomentaba la introducción de mejoras organizativas, así como la participación en las evaluaciones de la Red MCC-GEDAPS.

Cada centro enviaba en formato electrónico los datos anonimizadas de una muestra de al menos 5 pacientes por cada Unidad Básica Asistencial (médico/enfermera) y los datos eran agregados automáticamente por la comisión de coordinación de la red MCC-GEDAPS. En las evaluaciones de 1993 a 2002 se revisaron las historias de papel (muestreo sistemático o aleatorio, a criterio del centro) mientras que en 2007 se hizo revisando la historia informatizada y todas las muestras fueron aleatorias. Los datos se enviaban en un disquete hasta 2002 y entrando directamente los datos en la

página web www.redgedaps.org en 2007 [69]. Se debe tener en cuenta que la informatización en atención primaria fue progresiva: las primeras experiencias se iniciaron en 1998, se empezó a extender en 2001 y no se completó hasta el año 2005. Finalmente, desde el año 2006 los resultados de laboratorio y de la mayor parte de pruebas complementarias son volcados automáticamente en la historia clínica informatizada del ICS.

Tras la publicación de la primera edición de la Guía GEDAPS [33], se inició su difusión mediante un programa de formación continuada con una serie de actividades formativas presenciales y descentralizadas por toda la geografía catalana incluyendo aspectos de detección, manejo clínico y tratamiento, pero también la difusión de los resultados de las evaluaciones del programa de MCC-GEDAPS. Con posterioridad a cada una de las evaluaciones se editó un dossier con los resultados globales y por áreas geográficas que se envió a todos los centros de la Red MCC-GEDAPS. Además, se presentaron en las reuniones y cursos organizados por el grupo, así como en diferentes congresos de medicina de familia y de las sociedades nacionales e internacionales de diabetes. El feedback de los resultados a los centros participantes mediante el dossier, como al resto de centros de atención primaria, en cursos y reuniones científicas, ha podido constituir un estímulo importante para la mejora de la atención. Con los datos aportados por los centros de la red también se han generado numerosas publicaciones que han aumentado el conocimiento de la diabetes y su manejo en atención primaria [42–50].

2.4. Período 2007-2013: La base de datos poblacional SIDIAP

El ICS es el principal proveedor de servicios sanitarios de Cataluña y gestiona directamente 470 EAPs que tienen asignados más de 5,8 millones de ciudadanos, aproximadamente el 80% de la población catalana [70]. Todos los profesionales de atención primaria del ICS (más de 10.000) utilizan el mismo programa de historia clínica informatizada (la estación clínica de atención primaria [e-CAP]), creado y desarrollado por el propio ICS desde 1998. La

implantación del e-CAP fue progresiva a partir de 2001, y desde 2005 su uso es universal en todos los EAPs del ICS.

El Institut d'Investigació en Atenció Primària Jordi Gol (IDIAP-Jordi Gol) creó a finales de 2009 el SIDIAP (Sistema d'Informació per a l'Investigació en Atenció Primària; www.sidiap.org) [51,52]. Su objetivo principal es generar un gran sistema de información con datos provenientes de la historia clínica informatizada e-CAP del ICS y de otras fuentes complementarias (resultados de laboratorio, facturación de farmacia y altas hospitalarias, entre otros) que permita obtener información válida y fiable para la investigación. De esta forma, el SIDIAP ha permitido potenciar la investigación, fomentar la evaluación sanitaria del ICS y mejorar su gestión clínica.

El grupo DAP_CAT de la Unitat de Suport a la Investigació de Barcelona (IDIAP-Jordi Gol), comenzó en 2009 el proyecto eControl, con el objetivo de evaluar las características de los pacientes diabéticos de la base de datos del SIDIAP. Los datos sobre el grado de control glucémico y de otros factores de riesgo observados en el primer artículo publicado [53] son coherentes con los resultados obtenidos en otros estudios de nuestro país [45], especialmente con la evaluación GEDAPS de 2007 en Catalunya [44] y similares o incluso superiores a los de estudios realizados en otros países desarrollados [71–82] como veremos más adelante. La principal limitación de los datos del SIDIAP se debe a su diseño observacional, retrospectivo y transversal. Como cualquier estudio observacional, no toda la información clínica está disponible en todos los pacientes, pero el hecho de que incluye a toda la población, el elevado número de pacientes y el volumen de datos ofrece una visión muy fidedigna de la atención a la diabetes en el mundo real [54,60]. Con el objetivo de observar las tendencias en el manejo de la enfermedad se diseñó un proyecto en el que se han analizado los datos de cortes transversales anuales desde 2007 a 2013 y que ha sido motivo de una ayuda pre-doc de la IDIAP-Jordi Gol concedida en 2015 al doctorando con el fin de facilitar la realización de la tesis.

Desde el año 1993 hasta la actualidad se ha modificado sustancialmente la prevalencia de la DM2, se ha incrementado notablemente el arsenal terapéutico disponible para su control, así como la actitud terapéutica proactiva de los profesionales de atención primaria en el control y manejo de la enfermedad. La comparación de los datos de las evaluaciones del grupo GEDAPS de 1993 a 2007 con las de la base de datos SIDIAP de 2007 a 2013 nos permite conocer la evolución de los indicadores de control metabólico, el tratamiento y la presencia de complicaciones, en las condiciones de práctica clínica real en nuestro entorno. El objetivo principal de esta tesis es presentar y discutir los aspectos más destacados de la evolución del manejo de la enfermedad durante los últimos 20 años en Catalunya a través de las principales publicaciones de las que es autor el doctorando.

3. Hipótesis y objetivos

3.1 Hipótesis

Entre los años 1993 y 2013 se han producido cambios sustanciales en la prevalencia, manejo clínico y en los tratamientos disponibles que pueden ayudar a mejorar el control de los factores de riesgo cardiovascular en las personas con DM2, incluido el de la glucemia, y esto se puede traducir en una reducción de las complicaciones de la enfermedad. Las actividades de formación continuada y, más específicamente, de mejora de la calidad del grupo GEDAPS, así como las de las sociedades científicas y las instituciones sanitarias proveedoras de atención a las personas con diabetes, pueden haber generado una mayor capacitación y motivación de los profesionales sanitarios para el manejo de la enfermedad y esto, a su vez, repercutir positivamente en los indicadores de salud.

3.2. Objetivo principal

Identificar los potenciales cambios en el control de la DM2 en el periodo 1993-2013 en la población de Catalunya atendida por el sistema público de salud.

3.3. Objetivos secundarios

1. Describir la evolución de la prevalencia de la DM2 en Catalunya durante el periodo 1993-2013
2. Describir la evolución de los valores de HbA1c media en la población con DM2 en Catalunya durante el periodo 1993-2013
3. Describir la evolución del grado de control del resto de factores de riesgo cardiovascular modificables (PA, perfil lipídico, tabaquismo y obesidad) en la población con DM2 en Catalunya durante el periodo 1993-2013
4. Describir la evolución de la prevalencia de las complicaciones macro (cardiopatía isquémica, AVC, arteriopatía periférica) y microvasculares

(nefropatía, retinopatía) en la población con DM2 en Catalunya durante el periodo 1993-2013

5. Comparar específicamente los resultados de las evaluaciones de 2007: la del GEDAPS, basada en micromuestras, y la del SIDIAP, basada en una gran base de datos, con el fin de detectar diferencias y analizar los condicionantes o limitaciones que las puedan explicar
6. Describir la evolución del uso de fármacos antidiabéticos en la población con DM2 en Catalunya durante el periodo 2007-2013

4. Artículos

4.1 Primer Artículo

Quince años de mejora contínua de la calidad de la atención a la Diabetes tipo 2 en la Atención Primaria de Catalunya. ***International Journal of Clinical Practice, 2012***

ORIGINAL PAPER

IJCP THE INTERNATIONAL JOURNAL OF CLINICAL PRACTICE

Fifteen years of continuous improvement of quality care of type 2 diabetes mellitus in primary care in Catalonia, Spain

M. Mata-Cases,[1,2] P. Roura-Olmeda,[3] M. Berengué-Iglesias,[4] M. Birulés-Pons,[5] X. Mundet-Tuduri,[2,6] J. Franch-Nadal,[2,7] B. Benito-Badorrey,[7] J. F. Cano-Pérez,[8] on behalf of the Diabetes Study Group in Primary Health Care (GEDAPS: Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut, Catalonian Society of Family and Community Medicine)*

SUMMARY

Aims: To assess the evolution of type 2 diabetes mellitus (T2DM) quality indicators in primary care centers (PCC) as part of the Group for the Study of Diabetes in Primary Care (GEDAPS) Continuous Quality Improvement (GCQI) programme in Catalonia. **Methods:** Sequential cross-sectional studies were performed during 1993–2007. Process and outcome indicators in random samples of patients from each centre were collected. The results of each evaluation were returned to each centre to encourage the implementation of correcting interventions. Sixty-four different educational activities were performed during the study period with the participation of 2041 professionals. **Results:** Clinical records of 23,501 patients were evaluated. A significant improvement was observed in the determination of some annual process indicators: HbA_{1c} (51.7% vs. 88.9%); total cholesterol (75.9% vs. 90.9%); albuminuria screening (33.9% vs. 59.4%) and foot examination (48.9% vs. 64.2%). The intermediate outcome indicators also showed significant improvements: glycemic control [$HbA_{1c} \leq 7\%$ (< 57 mmol/mol); (41.5% vs. 64.2%)]; total cholesterol [≤ 200 mg/dl (5.17 mmol/l); (25.5% vs. 65.6%)]; blood pressure [≤ 140/90 mmHg; (45.4% vs. 66.1%)]. In addition, a significant improvement in some final outcome indicators such as prevalence of foot ulcers (7.6% vs. 2.6%); amputations (1.9% vs. 0.6%) and retinopathy (18.8% vs. 8.6%) was observed. **Conclusions:** Although those changes should not be strictly attributed to the GCQI programme, significant improvements in some process indicators, parameters of control and complications were observed in a network of primary care centres in Catalonia.

What's known

The results of clinical studies have shown that implementation of intervention programmes for the management of type 2 diabetes mellitus has a positive impact in quality of care. However, limited data are currently available from primary care settings.

What's new

The present study describes the impact of the Group for the Study of Diabetes in Primary Care intervention programme on type 2 diabetes mellitus quality of care in primary care settings in Spain by analysis of the trend of quality indicators.

[1]Primary Care Center (PCC) La Mina, Sant Adrià de Besòs, Barcelona, Spain
[2]Barcelona Ciutat Research Support Unit – IDIAP Jordi Gol, redIAPP, Barcelona, Spain
[3]PCC Badía del Vallés, Barcelona, Spain
[4]PCC Florida Nord, L'Hospitalet de Llobregat, Barcelona, Spain
[5]PCC Poblenou, Barcelona, Spain
[6]PCC El Carmel, Barcelona, Spain
[7]PCC Raval, Barcelona, Spain
[8]Servicio de Endocrinologia, Hospital del Mar, Barcelona, Spain

Correspondence to:
Manel Mata-Cases
PCC La Mina, C/Mar s/n.
08930, Sant Adrià de Besòs, Barcelona, Spain
Tel.: + 34 93 381 1593
Fax: + 34 93381 2141
Email: manelmatacases@gmail.com

*See Appendix.

Disclosure
The authors have nothing to declare.

Introduction

The benefits of controlling type 2 diabetes mellitus (DM) and the associated cardiovascular risk factors are well established and reflected in the current clinical practice guidelines (1–4). However, the results of several cross-sectional studies have highlighted the difficulties in achieving the goals as well as the full implementation of the clinical recommendations (5–9). The results of consecutive cross-sectional observational studies have shown some positive trends on both process indicators and degree of disease control (10–17).

Moreover, the results of several clinical trials conducted to evaluate different quality improvement programmes at both primary and secondary care centres have shown significant improvements in both process and intermediate outcome indicators (degree of glycemic control and other risk factors) with some impact on final outcome indicators like hospital admissions and health-related costs (18–20). The feedback of the indicators' results to the health providers is considered the basis for any quality improvement intervention (21–23). In Spain, there is limited information published in this regard, mainly from cross-sectional studies (5–9,17).

In 1992, the Group for the Study of Diabetes in Primary Care (GEDAPS) was founded by the Catalan Society of Community and Family Medicine to implement the aims of the Saint Vincent Declaration (1). In 1993, the group published the first edition of the 'Guidelines for Diabetes Management in Primary Health Care in Spain' that included both clinical and organisational recommendations and also defined a set of quality care indicators. The guidelines were updated in the following years (1995, 1998, 2000 and 2004) (2). In parallel, the group developed the GEDAPS continuous quality improvement (GCQI) computer programme to facilitate clinical audits. The programme constructed automatically process and outcome indicators based on the data recorded by the participant centres from random samples of patients' medical records. In 1996, the programme was expanded to other Spanish regions (17). The GCQI programme was mainly based on the feedback of the results of the clinical indicators to the participating centres to promote interventions to improve quality of care.

In 1993, the first evaluation of quality of care of type 2 DM in primary care settings took place in Catalonia. The evaluation was repeated in 1995, 1998, 2000, 2002 and 2007. At the same time, as part of the intervention, a series of workshops and seminars were launched to publicise and implement the GEDAPS guidelines as well as the recommendations to improve early detection of the disease, treatment, management of diabetes complications and specific workshops to analyse quality indicators and propose local interventions to improve patient's quality of care.

The aim of the present study was to describe the impact of the GEDAPS intervention programme on type 2 DM quality of care in primary care settings, by analysing the trend of quality indicators collected in assessments that took place between 1993 and 2007 in Catalonia, Spain.

Research design and methods

Study design

The GCQI programme gathered information from primary care centres (PCC) on process and outcomes indicators in a sample of their patients. To promote their participation, letters by ordinary mail and electronic mails (years 2000–2002) were sent to all PCC in Catalonia. The planned 2005 survey was not conducted because the medical records were being computerised during the previous years. During the last evaluation (2007), several investigator meetings around the territory were conducted to encourage participation in the study, regardless of their participation in the previous evaluations and to present changes in data entry using a webpage (http://www.redgdps.org/).

Health providers entered patient data using the GCQI computer programme that immediately provided the results of a set of disease-specific processes and outcomes indicators. Data were subsequently sent by disk (1993–2000), electronic mail (2002) or introduced directly in the redgedaps.org web (only in 2007). The GCQI computerised programme was specifically designed to perform periodic evaluations (audits) in primary care centres. The programme was based in two principles: data collection from each participant centre (each participant centre had a nurse or physician responsible of the survey) and subsequent data feedback to the centres. Thus, each centre was able to compare their data during subsequent assessments (internal comparison) and with data from other centres (external comparison). The gold standard for each indicator in each evaluation was the overall result of all the participating centres. Each centre then compared their own results with the global results (gold standard) to find differences that required to be improved.

Health providers were instructed to obtain a random sample from the medical records of type 2 DM patients with a follow-up greater than 6 months since diagnosis. A total sample of five patients multiplied for the number of basic care units (physician/nurse), with a minimum of 30 patients per centre, was required. A preselection of medical records with an additional 20% was performed. In those cases that did not fulfil the inclusion criteria the medical record was replaced by the next one of the same gender. Exclusion criteria included: type 1 DM; follow-up exclusively by an endocrinologist and short life expectancy (terminal patients or those that received home care).

Because of the retrospective nature of the study, based only on clinical records, patients were not required to give written informed consent. To assure anonymity, data were collected and recorded using two different files: one included demographic variables and the other one included clinical variables linked by a consecutive record number. The study design and the GCQI programme were presented and approved by the Consell Assessor de la Diabetis (Advisory Board on Diabetes) of the Health Department of the Autonomous Government in Catalunya that behaved as Institutional Review Board.

Data were collected from paper medical records from 1997 to 2002 and from electronic records in 2007. Data about the characteristic of the centre (rural or urban), number of doctors and nurses team (basic care units), total population and prevalence of

diabetes were fulfilled by the professional responsible of the evaluation.

GCQI programme interventions

The GCQI programme was mainly based on the feedback of the results of clinical indicators that were sent after each evaluation to the participating centres to promote interventions to improve quality of care. On the other hand, as part of the intervention programme, 55 courses, seminars and workshops were conducted during the study period to disseminate the GEDAPS Guidelines and its recommendations, and a total of 2041 health professionals (physicians and nurses) attended. The main aim of the courses and workshops was to encourage the global management of the disease, not only to improve glycemic control but also to promote the proper management of other cardiovascular risk factors as well as the performance of annual activities leading to early detection and treatment of diabetes complications. In relation to the nurses clinical activities, a special emphasis was put on reviewing the educational interventions, annual screening activities and the degree of disease control in each patient, and not be limited to explain diet or performing clinic measurements, that is the traditional role of nurses in our country.

Moreover, after the evaluations that took place in 1995 and 1998, nine decentralised workshops with the participation of 289 health professionals from 151 primary care teams (43% of the primary care centres of Catalonia), were conducted to analyse the results and identify healthcare difficulties to propose local corrective interventions.

Variables

Demographic and clinical characteristics

Age; gender; weight; height; body mass index (BMI), blood pressure; glycated haemoglobin (HbA_{1c}); total cholesterol and HDL-cholesterol; year of diabetes diagnosis; number of doctor or nurse visits, number of educational interventions recorded per year; antidiabetic treatment and smoking status.

Process and outcome indicators of quality of care

The following indicators, that have been previously described elsewhere, were studied (17): Process indicators: (i) related to the organisation: No visit related to diabetes recorded; less than three nursing visits; less than three educational interventions of different topic (whatever the number of visits required to perform the intervention for each topic); practice of self-monitoring blood glucose; (ii) laboratory measurements: at least one HbA_{1c} determination; two or more HbA_{1c} determinations; at least one total cholesterol determination; at least one HDL-cholesterol determination; at least one microalbuminuria screening determination; (iii) physical examinations: weight measurements (three or more times a year); funduscopy done by an ophthalmologist; foot examination; Outcome indicators: (i) intermediate outcomes: Good glycemic control ($HbA_{1c} \leq 7\%$ or 57 mmol/mol); acceptable glycemic control ($HbA_{1c} \leq 8\%$ or 68 mmol/mol); very poor glycemic control ($HbA_{1c} > 10\%$ or 89 mmol/mol); HDL-Cholesterol > 40 mg/dl (1.03 mmol/l); total cholesterol ≤ 250 mg/dl(6.47 mmol/l) (acceptable control); total cholesterol ≤ 200 mg/dl (5.17 mmol/l) (strict control); BMI < 30 kg/m^2; BP ≤ 140/90 mmHg (acceptable control); BP ≤ 130/80 mmHg (strict control); active smoking; (ii) final outcomes: diabetic foot (ulcers + amputations); diabetic foot ulcers; amputations of lower limbs; nephropathy (microalbuminuria or macroalbuminuria); retinopathy; amaurosis; coronary artery disease (including angina); stroke (including transient ischaemic attack); hospital admissions because of amputation, hypoglycemia or any other reason, but with plasma blood glucose > 500 mg/dl(27.28 mmol/l).

Statistical considerations

Continuous variables were described using the mean and standard deviation. Categorical variables are described as percentage with the confidence interval of 95% (95% CI). The SPSS.11 statistical program was used for all statistical analyses.

Results

During the study period (1993–2007) 55 seminars were conducted and a total of 2041 health professionals (physicians and nurses) from 1084 centres attended. Table 1 summarises the characteristics of the primary care participant centres. The PCC covered one-third of the population of Catalonia (7,364,068 individuals in 2007). The number of participant centres increased over time, from 1993 to 2002, with a decline during the last evaluation (2007). More than half of the centres were urban, reaching 67.3% in 2007. The prevalence of type 2 DM increased over time, from 3.3% in 1993 to 5.4% in 2007 (relative increase of 63%).

Patients' characteristics

The clinical records of 23,501 patients were evaluated. Table 1 summarises the characteristics of patients in each evaluation. Mean age increased from 65.2 years (SD: 10.2; range: 30–93) in 1993 to 67 years (SD: 10.9; range: 31–99) in 2007, with a significant progressive increase in the percentage of patients > 65 years old (50.9% vs. 60.2%). Other sig-

Table 1 Participant centres and patient characteristics in each evaluation*

	1993	1995	1998	2000	2002	2007
Characteristics of participant centres						
Number of participating centres	57	75	75	78	96	52
Urban centres (%)	54.4 (41.1–66.9)	56 (44.8–67.2)	56.6 (45.4–67.8)	52.6 (41.5–63.7)	57.3 (47.4–67.2)	67.3 (54.5–80.0)
Number of basic care units (physician + nurse)	433	565	609	680	846	637
Total assigned population	954,126	1,251,689	1,367,639	1,474,242	1,888,593	1,126,532
Assigned population over 14 years old	694,450	982,567	1,058,903	1,203,310	1,541,618	938,429
Number of patients with diabetes over 14 years	22,663	38,697	51,776	63,831	83,859	55,350
Prevalence of diabetes in patients over 14 years (%)	3.3 (3.0–3.5)	4.0 (3.8–4.2)	4.9 (4.7–5.1)	5.3 (5.1–5.5)	5.4 (5.2–5.5)	5.4 (5.2–5.6)
Patients' characteristics						
Number of participants	2239	3532	4217	4564	5819	3130
Gender (% female)	56.6 (54.5–58.6)	54.5 (52.9–56.1)	52.9 (51.4–54.4)	52.1 (50.6–53.5)	51.8 (50.5–53.1)	48.5 (46.7–50.2)
Age (years), mean (SD)	65.2 (10.2)	66.3 (10.3)	67.2 (10.6)	67.1 (10.8)	67.3 (10.9)	68 (11.7)
> 65 years old patients (%)	50.9 (48.8–53.0)	55.4 (53.8–57.0)	59.6 (58.1–68.1)	60.0 (58.6–61.4)	60.5 (59.2–61.8)	60.2 (58.5–61.9)
Diabetes duration (years), mean (SD)	7.5 (7.1)	7.8 (7.5)	8.2 (7.1)	7.6 (6.8)	8.0 (6.9)	7 (5.6)
Prevalence of obesity (BMI ≥ 30 kg/m^2) (%)	37.0 (35.0–39.0)	37.0 (35.4–38.6)	39.2 (37.7–40.7)	40.5 (39.1–41.2)	42.6 (41.3–43.9)	50.3 (48.5–52.0)
HbA_{1c} (%), mean (SD)	7.7 (1.9)	7.6 (1.6)	7.1 (1.6)	7.0 (1.7)	7.1 (1.4)	6.8 (1.4)
Physician visits related to diabetes, mean (SD)	3.7 (3.4)	2.9 (3.7)	2.7 (2.7)	2.8 (2.7)	2.6 (2.4)	4.1 (4.0)
Nurse visits related to diabetes, mean (SD)	5.1 (3.7)	5.1 (4.2)	4.6 (3.3)	4.2 (3.2)	3.6 (2.6)	4.8 (4.1)
Antidiabetic treatment (%)						
Diet and exercise alone	25.7 (23.9–27.5)	27.7 (26.2–29.2)	29.4 (28.0–30.8)	27.9 (26.6–29.2)	25.4 (24.3–26.5)	22.3 (20.8–23.7)
Oral antidiabetic drugs	52.2 (50.1–54.3)	50.0 (48.3–51.2)	49.9 (48.4–51.4)	51.7 (50.2–53.1)	54.6 (53.3–55.9)	60.5 (58.8–62.2)
Insulin (monotherapy)	20.0 (18.3–21.7)	20.2 (19.9–21.5)	17.8 (16.6–18.9)	15.2 (14.2–16.2)	12.3 (11.5–13.1)	7.3 (6.4–8.2)
Insulin + oral antidiabetic drug	2.1 (1.5–2.7)	2.0 (1.5–2.5)	2.8 (2.3–3.3)	5.2 (4.6–5.8)	7.6 (6.9–8.3)	10.0 (8.9–11.0)

*Data expressed as absolute numbers, means (standard deviation, SD) or percentages (95% confident interval)

nificant differences found between 1993 and 2007 evaluation included: lower number of female patients (56.6% vs. 48.5%); higher prevalence of obesity (37% vs. 50%); shorter time of diabetes duration (7.5 years vs. 7 years) and lower HbA_{1c} concentration (7.7% or 64 mmol/mol vs. 6.8% or 55 mmol/mol).

Throughout the study, more than half of the participants received oral antidiabetic treatment, whereas approximately 20% of the patients received insulin (alone or in combination therapy). Among this latter patient population, the percentage that received combined treatment (insulin + oral antidiabetics) increased significantly over time (2.1% vs. 10%) (Table 1).

Process indicators

Related to organisation

Throughout the study the number of patients that did not have any diabetes-related visit recorded significantly decreased (5.1% in 1993 vs. 2% in 2007), with an increase in the percentage of patients that visited the nurse more than three times per year (27.3% in 1993 vs. 31.5% in 2007). Doctors and nurses visits tend to decrease progressively, but increased in 2007. Likewise, a significant decrease was observed in the percentage of patients receiving less than three different annual educational interventions (74.6% in 1993 vs. 58.3% in 2007) (Table 2).

Control parameters

A significant increase in the number of annual analytical determinations of HbA_{1c} (51.7% in 1993 vs. 88.9% in 2007) and total cholesterol (75.9% vs. 90.0%) was observed (Table 2 and Figure 1A).

Complications screening

As for regular checkups, there has been improvement in the percentage of patients that have been tested

Table 2 Evolution of process and outcome indicators*

	1993 (*n* = 2239)	1995 (*n* = 3532)	1998 (*n* = 4217)	2000 (*n* = 4567)	2002 (*n* = 5819)	2007 (*n* = 3130)	Difference
Process indicators							
Related to the organisation							
No diabetes-related visit recorded	5.1 (4.2–6.0)	3.0 (2.4–3.6)	1.7 (1.3–2.1)	2.1 (1.7–2.5)	2.2 (1.8–2.6)	2.0 (1.5–2.5)	−3.1 (−4.1 to −2.0)
Less than three nursing visits	27.3 (25.5–29.2)	27.6 (26.1–29.1)	28.4 (27.0–29.8)	32.8 (31.4–34.2)	35.9 (34.7–37.1)	31.5 (29.9–33.1)	+4.2 (1.8 to 6.7)
Less than three educational interventions	74.6 (72.8–76.4)	56.3 (54.7–57.9)	61.2 (59.7–62.7)	67.2 (65.8–68.6)	64.6 (63.4–65.8)	58.3 (56.6–60.0)	−16.3 (−18.8 to −13.8)
Control parameters							
At least one blood pressure measurement	94.5 (93.6–95.4)	93.0 (92.2–93.8)	93.9 (93.2–94.6)	92 (91.2–92.8)	92.2 (91.5–92.9)	92.3 (91.4–93.2)	−2.2 (−3.5 to −0.9)
At least one HbA_{1c} measurement	51.7 (49.6–53.4)	70.2 (68.7–71.7)	77.6 (76.3–78.9)	82.8 (81.7–83.9)	85.3 (84.4–86.2)	88.9 (87.8–90.0)	+37.2 (34.9 to 39.5)
Two or more HbA_{1c} measurements	30.0 (28.1–31.9)	41.1 (39.5–42.7)	40.6 (39.1–42.1)	42.2 (40.8–43.6)	55.5 (54.2–56.8)	40.4 (38.7–42.1)	+10.4 (7.8 to13.0)
At least one total cholesterol measurement	75.9 (74.1–77.7)	80.5 (79.2–81.8)	83.1 (82.0–84.2)	84.4 (83.4–85.5)	86.5 (85.6–87.4)	90.9 (89.9–91.9)	+15.0 (13.0 to 17.1)
Weight control (three or more times a year)	44.9 (42.8–47.0)	32.7 (31.2–34.3)	31.3 (29.9–32.7)	33.5 (32.1–34.9)	40.5 (39.2–41.8)	40.2 (38.5–41.9)	−4.7 (−7.4 to −2.0)
Screening for complications							
Funduscopy performed by an ophthalmologist	52.2 (50.1–54.3)	48.4 (46.8–50.1)	52.6 (51.1–54.1)	52.2 (50.8–53.7)	54.3 (53.0–55.6)	49.0 (47.3–50.8)	−3.2 (−5.9 to −0.5)
Foot examination	48.9 (46.8–51.0)	58.3 (56.7–59.9)	54.3 (52.8–55.8)	54.1 (52.7–55.6)	56.6 (55.3–57.9)	64.2 (62.5–65.9)	+15.3 (12.6–17.9)
Determination of microalbuminuria	33.9 (31.9–35.9)	49.0 (47.4–50.7)	62.5 (61.0–64.0)	68.7 (67.4–70.0)	72.8 (71.7–73.9)	59.4 (57.7–61.1)	+25.5 (23.6–27.4)
Outcome indicators							
Intermediate outcomes							
Good glycemic control ($HbA_{1c} \leq 7\%$) (57 mmol/mol)	41.5 (39.5–43.5)	42.2 (40.6–43.8)	54.7 (53.2–56.2)	58.7 (57.3–60.1)	56.5 (55.2–57.8)	64.2 (62.5–65.9)	+22.7 (20.1 to 25.3)
Acceptable glycemic control ($HbA_{1c} \leq 8\%$) (68 mmol/mol)	62.6 (60.6–64.6)	65.4 (63.8–67.0)	74.0 (72.7–75.3)	77.6 (76.4–78.8)	78.6 (77.6–79.7)	83.3 (82.0–84.6)	+20.7 (18.3 to 23.1)
Very poor glycemic control ($HbA_{1c} \geq 10\%$) (89 mmol/mol)	13.4 (12.0–14.8)	10.4 (9.4–11.4)	5.7 (5.0–6.4)	5.7 (5.0–6.4)	4.6 (4.1–5.1)	4.2 (3.5–4.9)	−9.2 (−10.8 to −7.6)
HDL-cholesterol > 40 mg/dl (1.03 mmol/l)	74.7 (72.9–76.5)	72.2 (70.7–73.7)	77.2 (75.9–78.5)	78.0 (76.8–79.2)	77.6 (76.5–78.7)	83.0 (81.7–84.3)	+8.3 (6.5 to10.5)
Total cholesterol ≤ 250 mg/dl (6.47 mmol/l)	73.1 (71.3–74.9)	77.0 (75.6–78.4)	77.4 (76.1–78.7)	85.8 (84.8–86.8)	87.0 (86.1–87.9)	92.4 (91.5–93.3)	+19.3 (17.2 to 21.3)
Total cholesterol ≤ 200 mg/dl (5.17 mmol/l).	25.5 (23.7–27.3)	29.4 (27.9–30.9)	31.9 (30.5–33.3)	41.3 (39.9–42.7)	46.3 (45.0–47.6)	65.6 (63.9–67.3)	+ 40.1 (37.6 to 42.5)
Body mass index < 30 kg/m^2	63.0 (61.0–65.0)	63.0 (61.4–64.6)	60.8 (59.3–62.3)	56.9 (55.5–58.3)	57.4 (56.1–58.7)	49.7 (48.0–51.5)	−13.3 (−16.0 to −10.6)
BP ≤ 140/90 mmHg	45.4 (43.3–47.5)	47.4 (45.8–49.1)	50.1 (48.6–51.6)	54.9 (53.5–56.3)	58.8 (57.5–60.1)	66.1 (64.4–67,8)	+20.7 (18.0–23.3)
BP ≤ 130/80 mmHg	22.0 (20,3–23,7)	23.3 (21.9–24.7)	24.6 (23.3–25.9)	26.8 (25.5–28.1)	30.5 (29.3–31.7)	35.0 (33.3–36.7)	+13 (10.6–15.4)
Active smoking	13.4 (12.0–14.8)	14.3 (13.2–15.5)	15.0 (13.9–16.1)	14.4 (13.4–15.4)	15.4 (14.5–16.3)	13.6 (12.4–14.8)	−0.2 (−2.1 to 1.6)
Final outcomes (prevalence on complications)							
Diabetic foot (ulcers plus amputations)	9.5 (8.3–10.7)	6.0 (5.2–6.8)	4.2 (3.6–4.8)	3.5 (3.0–4.0)	3.0 (2.6–3.4)	3.2 (2.6–3.8)	−6.3 (−7.7 to −5.0)
Diabetic foot ulcers	7.6 (6.5–8.7)	5.4 (4.7–6.2)	3.4 (2.8–4.0)	2.7 (2.2–3.2)	2.3 (1.9–2.7)	2.6 (2.0–3.2)	−5 (−6.8 to −3.2)
Amputations of lower limbs	1.9 (1.3–2.4)	1.6 (1.2–2.0)	0.8 (0.5–1.1)	0.8 (0.5–1,1)	0.7 (0.5–0.9)	0.6 (0,3–0,9)	−1.3 (−1.9 to −0.7)
Nephropathy (micro or macroalbuminuria)	7.1 (6.0–8.2)	6.7 (5.9–7.5)	7.1 (6.3–7.9)	7.0 (6.3–7.7)	7.1 (6.4–7.8)	9.9 (8.8–11.0)	+2.8 (1.3 to 4.3)
Retinopathy	18.8 (17.2–20.4)	14.5 (13.3–15.7)	13.5 (12.5–14.5)	10.3 (9.4–11.2)	9.8 (9.0–10.6)	8.6 (7.6–9.6)	−10.2 (−12.1 to −8.3)
Amaurosis	2.7 (2.0–3.4)	3.3 (2.7–3.9)	3.1 (2.6–3.6)	2.1 (1.7–2.5)	2.1 (1.7–2.5)	0.3 (0.1–0.5)	−2.4 (−3.1 to 1.7)
Coronary artery disease	12.9 (11.5–14.3)	12.0 (10.9–13.1)	12.5 (11.5–13.5)	11.2 (10.3–12.1)	12.5 (11.7–13.4)	11.3 (10.2–12.4)	−1.6 (−3.4 to 0.2)
Stroke	6.8 (5.8–7.8)	6.8 (6.0–7.6)	6.6 (5.9–7.4)	5.9 (5.2–6.6)	5.7 (5.1–6.3)	6.3 (5.5–7.2)	−0.5 (−1.8 to 0.9)
Hospital admission for amputation, hypoglycemia or glycemia > 500 mg/dl (27.76 mmol/l)	3.8 (3.0–4.6)	4.9 (4.2–5.6)	6.3 (5.6–7.0)	7.6 (6.8–8.4)	6.8 (6.2–7.5)	6.8 (5.9–7.7)	+3.0 (1.8 to 4.2)

*All results are expressed as percentage with 95% confident interval related to the population of the year evaluated.

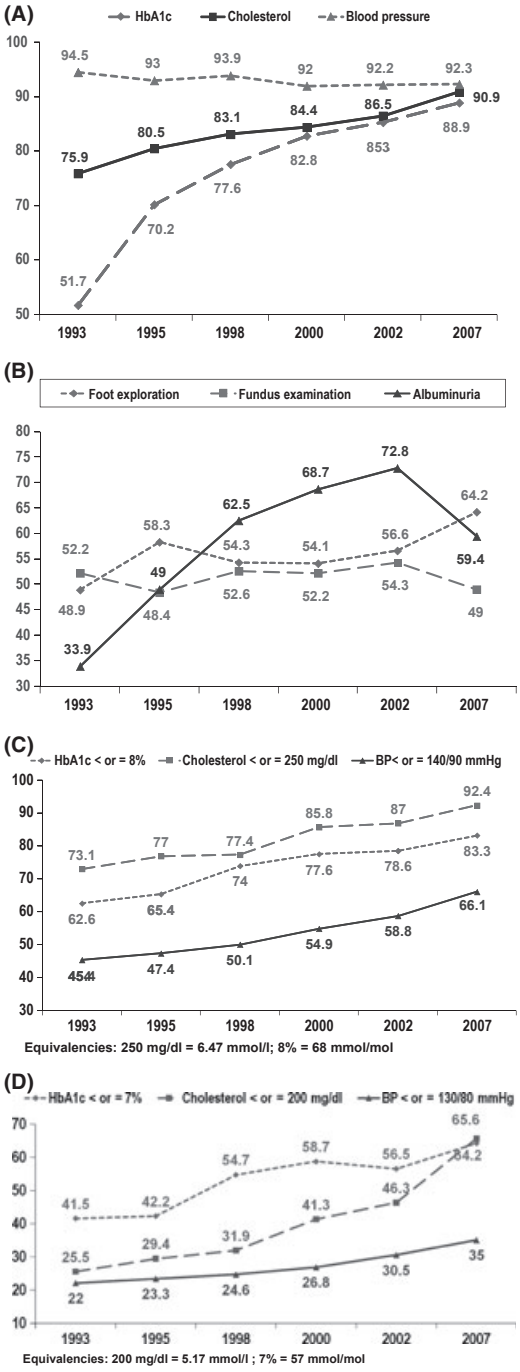


Figure 1 (A) Process indicators: HbA_{1c}, total cholesterol and blood pressure. Percentage of patients with at least one annual measurement. (B) Process indicators: complications screening. Percentage of patients with annual foot exploration, fundus examination and albuminuria screening. (C) Intermediate outcome indicators: percentage of patients with acceptable control of HbA_{1c}, total cholesterol and blood pressure. Equivalencies: 250mg/dl = 6.47 mmol/l; 8% = 68 mmol/mol. (D) Intermediate outcome indicators: percentage of patients with strict control of HbA_{1c}, total cholesterol and blood pressure. Equivalencies: 200mg/dl = 5.17 mmol/l; 7% = 57 mmol/mol

for microalbuminuria (33.9 in 1993 vs. 72.8% in 2002), although a fall was observed in 2007 (59.4%). The funduscopy examination initially improved, but then remained stable with some downward trend in the last assessment (52.2% vs. 49%). In addition, foot exploration increased significantly throughout the study (48.9% vs. 64.2%) (Table 2).

Outcome indicators

Trends in intermediate outcome indicators

Throughout the study significant improvements were observed in glycemic control, increasing the percentage of patients with $HbA_{1c} \leq 8\%$ or 68 mmol/mol (from 62.6% to 92% and reducing the number of patients with very poor glycemic control ($HbA_{1c} \geq 10\%$ or 89 mmol/mol) from 13.4% to 4.2%. In addition, a significant increase in the percentages of patients with acceptable control of total cholesterol (≤ 250 mg/dl-6.47 mmol/l), (from 73% to 92.4%) and blood pressure control (≤ 140/90 mmHg) (from 45.4% to 57.1%) was also noted (Table 2 and Figure 1B). Using more strict control criteria, $HbA_{1c} \leq 7\%$ or 57 mmol/mol increased from 41.5% to 64.2%, total cholesterol (≤ 200 mg/dl-5.17 mmol/l) from 25.5% to 65.6% and blood pressure (≤ 130/80 mmHg) from 22% to 35% (Table 1 and Figure 1C). In contrast, no change in the percentage of active smokers (13.4% and 13.6%) and an increase in obese patients (BMI ≥ 30) (from 37% to 50%) were noted (Table 2).

Trends in final outcome indicators

There has been a significant decrease in the prevalence of retinopathy (from 19.8% to 8.6%) and a slight increase in the prevalence of nephropathy (micro or microalbuminuria, from 7.1% to 9.9%) (Table 2). Prevalence of diabetic foot ulcers (from 7.6% to 2.6%) and amputation (from 1.9% to 0.6%) has also significantly decreased. In contrast, reductions in macrovascular complications have been much poorer: ischaemic heart disease (12.9% vs. 11.3%) and stroke (6.8% vs. 6.3%). The number of patients that required hospital admission because of hyperglycemic decompensation increased significantly throughout the study (from 3.8% to 6.8%).

Discussion

The present study analyses the evolution of type 2 DM management in primary care settings in Catalonia. During the study period, a significant increase in the prevalence of DM2 and obesity was observed, probably related to the epidemic increase in the prevalence of obesity in the western countries during

the last decades. However, there were no important changes in the mean age and sex distribution, duration of the disease and steps of treatment.

The significant improvements observed in some of the process indicators, in particular glycemic control, blood pressure and cholesterol, may have contributed to the reduction of key chronic complications associated with the disease, such as retinopathy and diabetic foot. These improvements meet the expectations of reducing the percentage of complications included among the goals of the Declaration of Saint Vincent (1).

The analysis of the evolution of process indicators highlight the improvement of laboratory measurements (HbA_{1c}, cholesterol, and albuminuria) that are essential to assess the need or the effect of treatments as well as patient risk. However, the limited improvement observed in foot and funduscopy examinations noted in the study should be carefully analysed because such explorations are essential to early detection.

The improvements in type 2 DM process indicators observed in the present study are comparable with the trends described in other studies. Thus, the results of a population-based study that compared the results of successive cross-sections in 1988 (1024 patients) and 2006 (13,078 patients) to assess changes in quality of type 2 DM care in United States by using standardised measures showed a significant improvement in HbA_{1c} (from 34% to 51%), funduscopy (from 63.2% to 67.7%) and foot examination (from 65.4% to 68.3%) (10). Similarly, in another study conducted among Medicare beneficiaries with diabetes between 1992 (150,000 patients) and 2001 (230,000 patients) the number of HbA_{1c} and funduscopy examinations significantly increased (from 31% to 76% and from 49% to 57% respectively) (11). Other studies conducted in the UK, Israel, Netherlands, Sweden and U.S. also show improvements in the indicator trends although such studies had limitations regarding the number of patients analysed (reduced sample sizes) and length of follow-ups (< 5 years) (13–16). The effect of pay-for performance on the quality of primary care has been recently evaluated in England (16).

The improvement in all composite measures of quality (80% and 90% in the determination of HbA_{1c}, blood pressure and lipids) confirmed the benefits of such strategy. In addition, between 1998 and 2007 foot exploration increased from 57.4% to 91.5% and funduscopy examination from 69.4% to 81.1%. Such increases were significantly higher than those observed in our study.

With regard to intermediate outcomes in the British intervention, the proportion of patients who achieved the target A_{1C} value (≤ 7.5%) increased from 59.1% to 66.7%, the proportion that achieved the target BP (≤ 145/85 mmHg) increased from 70.9% to 80.2%, and finally, the proportion that achieved the target TC value (≤ 5 mmol/l) increased from 72.6% to 83.6%[16]. Although the differences in the targets between the British intervention and our study does not allow a head-to-head comparison of the results; nevertheless both showed a similar positive trend.

In the Spanish health system the role of nurses in the management of type 2 DM has increased steadily over the past 20 years. Nurses often perform, in addition to educational endeavours, foot examination as well as analytical determinations and funduscopy examination requests. Therefore, it is important to highlight their potential role in the improvements obtained in the present study. In fact, different experiences in the U.S. have shown that nurses can achieve equal or better results compared with physicians, especially when are provided with software tools to help decision-making (24–26).

Concerning the changes observed in the present study with regard to intermediate and final outcome indicators should not be attributable solely to the GCQI programme, but instead, are a reflection of the progressive changes in type 2 DM disease management experienced by our health system. This time trend of improvement in diabetic control has also been observed in prior cross-sectional studies conducted in US (10,11) and Europe (12,14,15). Moreover, an improvement in outcome indicators has also been described in a prior study conducted in the US. Thus, medical records from Medicare patients, analysed between 1992 (150,000 patients) and 2001 (230,000 patients) showed a reduction of foot amputations in 22% associated with a 4% increase in the prevalence of retinopathy (11).

The significant reduction observed in diabetic foot lesions and retinopathy may reflect the educational and prevention interventions conducted by the health professionals. However, these improvements may also be due in part to the intensification of type 2 DM diagnosis screenings, the lowering of the glycemic cut-offs in the 1997 diagnostic criteria from 140 to 126 mg/dl (7.77–7 mmol/l) and the improvement in diagnosis registration. Such changes have led to the inclusion of patients in earlier stages of the disease and therefore increasing the percentage of patients belonging to the less severe category. This could explain the fact that the HbA_{1c} percentage and the prevalence of microvascular complications or time since diagnosis have decreased in recent assessments. However, the prevalence of heart disease and stroke has not decreased and this could be because of the similar mean age of patients in each evaluation and the limited impact of glycemic control on macrovas-

cular complications (27). Finally, one unexpected result is the slight increase observed in hospital admissions that could be explained by an improvement in clinical records, but we cannot exclude an increase in severe hypoglycemia because of the intensification of pharmacological treatment. As the indicator only includes the number of admissions, but not the reason, it is impossible to discard the possible effect of the feedback of the results on glycemic control that could lead to an overtreatment of some patients. However, as the results about glycemic control are from the whole centre and not at individual level (nor doctor neither patient) it seems improbably that the feedback could affect directly their patients. At the same time, the threshold for the intensification of treatment in our GEDAPS guidelines and in the pay-for-performance of our institution was 8% and this relatively soft threshold could protect our patients from overtreatment. The registration of the number of severe hypoglycemic episodes would be a very interesting indicator to add to future audits.

The main limitations of this study include the design of the study, based on quality interventions rather than epidemiological or investigational purposes, and the lack of a control group. Because of the voluntary participation of the centres and the length of the study it has been impossible to recruit a group of centres from other areas or regions acting as a control group. In relation to the validity of collected data, studies of quality improvement are based on the principle that all unregistered activity is considered not being made. Taking into account the overloaded conditions of working in primary care it can be assumed that health professionals were not able to perform a comprehensive record of the activities, especially in educational issues. In the study period, the computerised medical record was generalised throughout primary care in Catalonia from 2003 to 2004, therefore almost all the medical records reviewed until 2002 were handwritten. In contrast, in the 2007 assessment results were collected from electronic medical records, which may explain the increased number of visits or foot examinations registered in the last assessment. However, no improvements in funduscopy examination or nephropathy screening were observed. As for any study of continuous quality improvement programme, it should not be ruled out that the observed improvements are merely a reflection of an upgrading in medical record registration (23,28). However, some studies suggest that improvements in electronic management system are not always accompanied by improvements in health outcomes (20).

Another possible limitation of the study is that participation was voluntary, therefore it could be hypothesised that only more motivated centres for diabetes control participated in the assessments. However, the fact that the health provider responsible for data reviewing was motivated did not preclude that the remaining professionals of the PCC were motivated for diabetes management.

Finally, we must raise the question of whether improvement in process indicators involves improvements in health outcomes indicators. Most interventions show an improvement of the process indicators and intermediate outcomes (21–23,28). The comprehensive registration of activities does not guarantee a strict clinical attitude and therefore treatment modification or intensification could not be associated with achievement of treatment goals. However, there is consensus that process indicators are the only tools to monitor the impact of quality interventions because final outcome indicators are neither considered sensitive nor specific as quality of care measures (28).

It can be concluded that during the study period there have been improvements in the registry of health activities as well as performance of physical examinations and laboratory tests. The improvements achieved in glycemic control and other risk factors may have contributed to the reduction in foot amputations and diabetic retinopathy observed. Although those changes should not be attributed strictly to the GCQI programme, they reflect an improvement in the health of type 2 DM patients managed in primary care in our country.

Acknowledgements

All the members of the GEDAPS group, physicians and nurses included in Appendix 1, without whose commitment to quality of care it would not have been possible to carry out this study and Sofía Perea, Pharm D, PhD, who provided medical writing support funded by Merck Sharpe & Dohme Spain, S.A. The GEDAPS group Continuous Quality Improvement Programme has received financial support from Bayer, Novo Nordisk, GlaxoSmithKline, Merck Sharp & Dhome Spain, and the Fundació d'Atenció Primària. The authors of the manuscript have nothing to declare.

Authors' contributions

MCM, ROP, BIM, BPM, MTX, FNJ, BBB, and CPJF participated in the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, and final approval of the version to be submitted.

References

1 Krans HMJ, Porta M, Keen H, Diabetes Care and research in Europe. *The Saint Vincent Declaration Action Programme*. Ginebra: WHO Regional Office for Europe, 1992.

2 Cano JF, Franch J, Mata M, Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut (GEDAPS). *Guia para el tratamiento de la diabetes tipo 2 en Atención Primaria*, 4ª edición. Madrid: Harcourt Ed, 2004.

3 IDF Clinical Guidelines Task Force. Global Guideline for Type 2 Diabetes: recommendations for standard, comprehensive, and minimal care. *Diabet Med* 2006; **23**: 579–93.

4 American Diabetes Association. Standards of medical care in diabetes 2010. *Diabetes Care* 2010; **33**: 11–61.

5 Liebl A, Mata M, Eschwege E. Evaluation of risk factors for development of complications in type II diabetes in Europe. *Diabetologia* 2002; **45**: S23–8.

6 De la Calle H, Costa A, Díez-Espino J, Franch J, Goday A. Evaluación del cumplimiento de los objetivos de control metabólico de la diabetes mellitus tipo 2. Estudio TranSTAR. *Med Clin (Barc)* 2003; **120**: 446–50.

7 Benito López P, García Mayor R, Puig Domingo M et al. Perfil de los pacientes con diabetes mellitus tipo 2, en la Atención Primaria española. *Rev Clin Esp* 2004; **204**: 18–24.

8 Orozco-Beltrán D, Gil-Guillen VF, Quirce F et al. Control of diabetes and cardiovascular risk factors in patients with type 2 diabetes in primary care. The gap between guidelines and reality in Spain. *Int J Clin Pract* 2007; **61**: 909–15.

9 Mengual L, Roura P, Serra M, Montasell M, Prieto G, Bonet S. Multifactorial control and treatment intensity of type-2 diabetes in primary care settings in Catalonia. *Cardiovasc Diabetol* 2010; **9**: 14.

10 Saaddine JB, Cadwell B, Gregg EW, Engelgau MM, Vinicor F, Imperatore G, Narayan KMV. Improvements in diabetes processes of care and intermediate outcomes: United States, 1988–2002. *Ann Intern Med* 2006; **144**: 465–74.

11 Kuo S, Fleming BB, Gittings NS et al. Trends in care practices and outcomes among Medicare beneficiaries with diabetes. *Am J Prev Med* 2005; **29**: 396–403.

12 Campbell SM, Roland MO, Middleton E, Reeves D. Improvements in quality of clinical care in English general practice 1998-2003: longitudinal observational study. *BMJ* 2005; **331**: 1097–8.

13 Rothe U, Müller G, Schwarz PE et al. Evaluation of a diabetes management system based on practice guidelines, integrated care, and continuous quality management in a Federal State of Germany: a population-based approach to health care research. *Diabetes Care* 2008; **31**: 863–8.

14 Club Diabete Sicili@. Five-year impact of a continuous quality improvement effort implemented by a network of diabetes outpatient clinics. *Diabetes Care*, 2008; **31**: 57–62.

15 Cooper JG, Claudi T, Jenum AK et al. Quality of care for patients with type 2 diabetes in primary care in Norway is improving: results of cross-sectional surveys of 33 general practices in 1995 and 2005. *Diabetes Care* 2009; **32**: 81–3.

16 Vaghela P, Ashworth M, Schofield P, Gulliford MC. Population intermediate outcomes of diabetes under pay-for-performance incentives in England from 2004 to 2008. *Diabetes Care* 2009; **32**: 427–9.

17 Franch Nadal J, Artola Menéndez S, Diez Espino J, Mata Cases M, en representación de la Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud. Evolución de los indicadores de calidad asistencial al diabetico tipo 2 en la atención primaria de España (1996-2007). Programa de la mejora continua de calidad de la Red de Grupos de Estudios de la Diabetes en Atención Primaria de la Salud. *Med Clin (Barc)* 2010; **135**: 600–7.

18 Renders CM, Valk GD, de Sonnaville JJ et al. Quality of care for patients with Type 2 diabetes mellitus – a long-term comparison of two quality improvement programmes in the Netherlands. *Diabet Med* 2003; **20**: 846–52.

19 Wandell PE, Gafvels C. Metabolic control and quality of data in medical records for subjects with type 2 diabetes in Swedish primary care: improvement between 1995 and 2001. *Scand J Prim Health Care* 2002; **20**: 230–5.

20 Wagner EH, Grothaus LC, Sandhu N et al. Chronic care clinics for diabetes in primary care: a system-wide randomized trial. *Diabetes Care* 2001; **24**: 695–700.

21 Montori VM, Dinneen SF, Gorman CA et al. The impact of planned care and a diabetes electronic management system on community-based diabetes care: the Mayo Health System Diabetes Translation Project. *Diabetes Care* 2002; **25**: 1952–7.

22 Shojania KG, Ranji SR, McDonald KM et al. Effects of quality improvement strategies for type 2 diabetes on glycemic control: a meta-regression analysis. *JAMA* 2006; **296**: 427–40.

23 Guldberg TL, Lauritzen T, Kristensen JK, Vedsted P. The effect of feedback to general practitioners on quality of care for people with type 2 diabetes. A systematic review of the literature. *BMC Fam Pract* 2009; **10**: 30.

24 Aubert RE, Herman WH, Waters J et al. Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization: a randomized trial. *Ann Intern Med* 1998; **129**: 605–12.

25 Taylor CB, Miller NH, Reilly KR et al. Evaluation of a nurse care care management system to improve outcomes in patients with complicated diabetes. *Diabetes Care* 2003; **26**(4): 1058–63.

26 Davidson MB, Ansari A, Karlan VJ. Effect of a nurse-directed diabetes disease management program on urgent care/emergency room visits and hospitalizations in a minority population. *Diabetes Care* 2007; **30**(2): 224–7.

27 Lilford RJ, Brown CA, Nicholl J. Use of process measures to monitor the quality of clinical practice. *BMJ* 2007; **335**: 648–651.

28 Khunti K, Gadsby R, Millett C, Majeed A, Davies M. Quality of diabetes care in the UK: comparison of published quality-of-care reports with results of the Quality and Outcomes Framework for Diabetes. *Diabet Med* 2007; **24**: 1436–41.

Appendix 1: List of participating investigators in the GEDAPS evaluations

Mª Victoria Abellan, Mª Teresa Adell; Raquel Adoer; Mª Eugenia Adzet; Carina Aguilar; Emilia Alabau; Inmaculada Alegre; Mercé Algans; Herminia Algilaga; Mercedes Aliaga; Rosa Alie; Josep Alins; Carmen Almirall; Josep Almirall; Amelia Alonso; Otilia Alonso; Tomas Alonso; Judit Alsina; Ana María Altaba; Isabel Alvarez; Mercedes Alvarez; Mercé Alvarez; Francesc Anguera; Gloria Antón; Charo Añaños; J. Ignacio Aoiz; Enric Aragonés; Eugenia Arasa; Mª Josefa Arasa; Teresa Areny; Teresa Arnau; Enric Arroyo; Carmen Asensio; Mercé Aubanell; Francisco Avila; Teresa Aviño; Pilar Babi; María Badenes; Rosa Maria Badia; Pilar Baillo; Josep Lluía Ballvé; Carmen Baquer; Elena Barnat; Mª Carmen Barrero; Joan Barrot; Rosa Ana Bas; Núria Bastida; Enric Bayona; Domenech Benaigues; Mª Rosa Benedicto; Belén Benito; Carmina Bentue; María Berengué; Marta Berga; Francisco Berlanga; Martí Birules; Alba Blanch; Mª Isabel Bobé; Miriam Boira; Neus Bonamusa; Neus Boqué; Eulalia Borrell; Manel Borrell; Montserrat Bosch; Concepción Bou; Consol Bou; Javier Buil; Magda Bundo; Esther Caballé; Isabel Caballero; Mª Carmen Caballero; Josep Caballero; Rosa Caballol; Teresa Cabases; Juan Josep Cabré; Mª Angels Calaf; Glora Mª Calleja; Maria Luisa Calvet; Ramón Camps; Rosa Canals; Silvia Canivell; Juan Francisco Cano; Josep Cañellas; Dolors Capdevilla; Anna Carabi; Carmen Carretero; Carolina Carrillo; Ricart Carillo; Mª Angels Casals; Jordi Casanovas; Nieves Casbas; Pilar Casellas; Mª José Castany; Mercé Castaño; Mª Jose Castelar; Carme Castelló; Joan Castells; Dolors Catalá; Matilde Catalá; Mª Jesús Cerain; Encarnación Checa; Ester Chiveches; Carmen Ciria; A. Claramunt; Purificación Claver; Joan Clotet; Yolanda Coccor; Fina Coll; Josep Coll; Montserrat Coma; Vicent

Coma; Josefina Comas; Joan Conxat; Ferran Cordon; Carmen Coronado; Carme Cortina; Francesc Xavier Cos; Pilar Coscullera; Engracia Costa; Joan Costa; Xavier Costa; Jose Mª Cots; Ramon Creus; Inés Cruz, Lourdes Cruz; Nuria Culi; Montserrat Dalmau, Josep Davins; M. Teresa de Cos; Josep Anton de la Fuente; Nuria de la Iglesia; Mercé de la Torre; Juan A de Luna; Lourdes de Marcos; Rosa Mar de Miguel; Marta de Puig; Marta del Moral; Carmen Delgado; Francisca Delgado; Cecilia Domenech; José María Domingo; María Isabel Domingo; Roser Dot; Carme Echevarria; Pilar Enseñat, Mª Luisa Escandón; Mercé Escarrá; Alex Escosa; Lídia Escur; Jordi Espinás; Montserrat Espuga; Teresa Esquerra; Marià Esquerrá; Josefa Estany; Montserrat Estruch; Sion Fabregat; Antonia Fargas; Assumpta Farrás, Pere Farrás; Montserrat Farrús; Eugeni Fau;Montserrat Fernandez; Carmen Fernández; Maria Rosario Fernández; Pablo Fernández; Mª Carmen Fernández; Judit Ferragutcasas; Maria Ferré; Daniel Ferrer-Vidal; Xavier Figueras, Xavier Flor; Carme Florensa; Pere M.Flores; Quintí Foguet; Mar Foix; Pilar Font; Jordi Forcada; Maria Carme Forn; Josep Franch; Rosa Freixedes; Miquel Fuentes; José Mª Fuste; Pilar Fusté; Carmen Galera; Gisela Galindo; Roser Galitó; Anna Mª Garcia; Eva Garcia; Isabel Garcia; J. Manel Garcia; Laura Garcia; Vega Garcia; Gracia Garcia; Concepció Garcia; M. Teresa Garcia; Jose Maria Garrido; Anna Gasol; M. Amparo Gaytano; Dolors Gelabert; Jordi Gentille; Francesc German; Faustino Gerri; Rosa M Gimbert; Virginia Golobart; Josep Gomà; Albert Gomez; Alicia Gonzalez; Clementina Gonzalez; J. Carles Gonzalez; Matilde Gonzalez; Tamara Gonzalez; Maria Gonzalez; Mª Rosa Gorgot; Lluís Gracia; Imma Grau; Neus Gregori; Montserrat Grivé; Teresa Gros; Elisenda Guarné; Asunción Guarner; Faustino Guerri; Jesús Domingo Guevara; Mª Antònia Gutíerrez; María Cruz Guzmán; Anna Rosa Hernandez; Mª Mercè Hernandez; Enric Hernández; Anna Hernández; Juan Herreros; Beatriz Hortangas; Monica Ibañez; Carme Iglesias; Pedro Iglesias; Pascual Jaime; Ricardo Jara; Rosa Juanola; Joan Juvanteny; Eduard Kronfly; Cristina Laserna; Carmen Lecumberri; Xavier Lecumberri; Montserrat Ledesma; M. José Ledó; Mª Antonia Llauger; Josep Lluís Llor; Judit Llussà; Flora Lopez; Regina Lopez; Angels López; Anna López; M.José Lorente; Gustavo Losada; Joan Lozano; Marissa Madrid; Carme Mallorqui; Sara Marcelo; Yolanda Marcos; M. Victoria Marina; Carmen Marquilles; Jordi Marti; Laia Martí; Raquel Martín; José Antonio Martin; Ana Martinez; Daniel Martinez; Dolores Martinez; Dolors Martinez; Ignacio Martinez; Miguel Martinez; Carmen Martinez; Rafael Martinez; Valenti Martinez; Sara Martinez de Arenzana, Raquel Martos; Rosa Mª Masdeu; Anna Masseda; Josep Massons; Manel Mata; Enriqueta Matheu, Anna Mayoral; Laura Mayordomo; Pilar Medina; Salvador Medina, Cèlia Melèndez; Ana Menal; Mª Angeles Méndez; Miquel A. Mercadè; Josep Mercader; Xavier Mestre; Concepción Mestres; Rosa Mar Miguel; Anna Miralbés; Mercè Miranda; Sònia Miravet; Magda Mitjavila; Àngels Mollói Josep Felip Monclus; Susanna Montesinos; Javier Monteverde; Sandra Moraleda; Carlos Moreno; Maria de la Sierra Moreno; Miguel Moreno; Rocío Moreno; Xavier Mundet; Pere Munt; Aser Muñoz; Roser Muñoz; Marife Muñoz; Rosa Blanca Muñoz; Josep Murria; Josep Mussoll; Carme Nabau; Carmel Nadal; Antonia Navarro; Juan Navarro; Maria del Mar Navarro; Pilar Navarro; Cristina Nieto; Vicente Nieto; Pere Noe; Ana M.Nogales; Concepcion Nogués; Marisol Oliva; Irene Oliva; Mercedes Oliver;Mª Angels Oliveras; Miquel Oller; Montserrat Ortigas; Jacinto Ortiz; Jose Osvet; Isabel Otzet; Antonio Padilla; Jesús Pages; Elisenda Palet; Merce Pallarés; M. Pilar Pallarés; Mª Teresa Pallerols; Nuria Palou; Clara Pareja; Rosa Pascual; Maria Pastoret; M. Florencia Patittucci; David Pedrico; Magda Pedrosa, Margarida Pelegri; Francisca Peñas; Josep Maria Pepió; Consol Peracaula; Julio Perez; Elena Pérez; Miguel Peso;Jordi Pi; Magda Pi; Antoni Plana; Isabel Plaza; Montserrat Policarpio; Isabel Porta; Montserrat Portas; Joan Prat; Paloma Prats; Pilar Prellezo; Neus Profitós; Francesc Puig; Josep Puig; Marta Puig; Xavier Puigdengolas; Montserrat Pujiiula; Ramon Pujol; Dolors Pujol; Francisca Puntes; Núria Rabentós; Joana Ramon; Ana Maria Ramos; Estibaliz Redondo; David Riba; Fidel Riba Barrés; Enriqueta Ribas; Ricart Ribas; Teresa Ribé; Trinitat Ribes; Carme Riera; Natàlia Riera; José Luís Rivero; Rosabel Roca; Antonio Rodriguez; Francisco Rodriguez; Javier Rodriguez; Mònica Rodríguez; Olivia Roig; Montserrat Romaguera; Xavier Romani; Eva Romero; Mª Dolors Romero; Esther Ros; Pilar Roura; Montserrat Roures; Aurora Rovira; Carles Rubio; Laura Rubio; Montserrat Rubio; Irene Ruiz; M.Paz Ruiz; Miriam Ruiz; Joana Ruiz; Teresa Sabartes; Primitivo Sabaté; Maria A.Sagarra; Josep M Sagrera; Isabel Sales; Anneliese Salzer; Angela Sanchez; Rosalia Sanchez; Yolanda Sanchez; Carme Sánchez; Josep M.Sánchez; Consol Sánchez; Enric Sanchis; Teresa Sangra; Laura Sanguesa; Maria Sanmartin; Neus Saun; Meritxell Saura; Montserrat Saus; Carme Sebastià; Eva Segura; Amparo Segura; Gemma Sellas; Beatriz Sena; Mª José Sender; Dolores Serra; Marta Serra; Imma Serrabasa; Lidón Serrano; Vanesa Serrano; Maria Serratosa; Angels Sieria; Silvia Sierra; Josep Mª Sierra; Josefina Sirvent; José Francisco Sobrino; Silvia Solà; Pascual Solans; Mª Carmen Soldado; Júlia Solé; Montserrat Solé; Magda Solé; Merce Soler; Luís Solsona; Mª Teresa Sopena; Marta Sorribes; Edith Steiner; Ana Mª Suarez; Esperanza Suros; Robert Surriba; Pau Surribes; M. Luz Talavera; Sol Taramon; Maria Victoria Tarin; Salvador Tarradas; Eduard Tarrago; Luisa Tarrida; Joan Tobias Pedro Tomás; Marta Torne; Anabel Torras; Emma Torres; Natividad Torres; Josep Ubach; Antonio Ubieto; Sara Unanue; Luís Carlos Valladares; María José. Vendrell; Cristina Verdera; Maria Vernet; Raquel Vicente; Roser Vicente; Antonieta Vidal; Mª Antonia Vila; Carme Vila; Marga Vilageliu; Luisa Vilaginer; Josep Vilalta; Pere Vilalta; Eulàlia Vilaplana; Esther Viler; Lidia Villagrasa; Merce Villaro; Jordi Villegas; Antoni Vives; Rosa Vives; Nuria Xifro; Rosa Elena Yañez; Montserrat Zamora

Paper received September 2011, accepted November 2011

4.2 Segundo Artículo

Control de la glucemia y los factores de riesgo cardiovascular en pacientes con Diabetes tipo 2 en la Atención Primaria de Catalunya. ***Diabetes Care, 2012.***

Control of Glycemia and Cardiovascular Risk Factors in Patients With Type 2 Diabetes in Primary Care in Catalonia (Spain)

Irene Vinagre, md[1]
Manel Mata-Cases, md[2,3]
Eduard Hermosilla, bsc[3]
Rosa Morros, md[3,4]
Francesc Fina, md[3,5]
Magdalena Rosell, md[3]
Conxa Castell, md, phd[6]
Josep Franch-Nadal, md, phd[3,7]
Bonaventura Bolíbar, md, mph[3,4]
Didac Mauricio, md, phd[8,9]

OBJECTIVE—The objective of this study was to analyze the clinical characteristics and levels of glycemic and cardiovascular risk factor control in patients with type 2 diabetes that are in primary health care centers in Catalonia (Spain).

RESEARCH DESIGN AND METHODS—This was a cross-sectional study of a total population of 3,755,038 individuals aged 31–90 years at the end of 2009. Clinical data were obtained retrospectively from electronic clinical records.

RESULTS—A total of 286,791 patients with type 2 diabetes were identified (7.6%). Fifty-four percent were men, mean (SD) age was 68.2 (11.4) years, and mean duration of disease was 6.5 (5.1) years. The mean (SD) A1C value was 7.15 (1.5)%, and 56% of the patients had A1C values ≤7%. The mean (SD) blood pressure (BP) values were 137.2 (13.8)/76.4 (8.3) mmHg, mean total cho-lesterol concentration was 192 (38) mg/dL, mean HDL cholesterol concentration was 49.3 (13.2) mg/dL, mean LDL cholesterol (LDL-C) concentration was 112.5 (32.4) mg/dL, and mean BMI was 29.6 (5) kg/m^2. Thirty-one percent of the patients had BP values ≤130/80 mmHg, 37.9% had LDL-C values ≤100 mg/dL, and 54.6% had BMI values ≤30 kg/m^2. Twenty-two percent were managed exclusively with lifestyle changes. Regarding medicated diabetic patients, 46.9, 22.9, and 2.8% were prescribed one, two, or three antidiabetic drugs, respectively, and 23.4% received insulin therapy.

CONCLUSIONS—The results from this study indicate a similar or improved control of glycemia, lipids, and BP in patients with type 2 diabetes when compared with previous studies performed in Spain and elsewhere.

Diabetes Care 35:774–779, 2012

Type 2 diabetes is a chronic disease with a prevalence of 13.8% in people over 18, with up to 6% of the population remaining undiagnosed, according to a recent Spanish study (1). Because diabetic patients have a higher risk of developing microvascular disease and a two- to fourfold higher risk of developing macrovascular disease than the general population, type 2 diabetes is considered to be among the top conditions with the greatest health and economic impact (2). Many studies have shown that the occurrence of these complications depends largely on the degree of glycemic control and intensive control of cardiovascular risk factors (CVRFs) (3–5).

In the last few decades, a consensus toward the implementation of a multidisciplinary approach to prevention and control of patients with type 2 diabetes in primary care has been reached. Since 1993, the Spanish Group of Study of Diabetes in Primary Health Care (Gedaps) has published up-to-date guidelines with the main recommendations for diagnosis, control, and treatment of diabetes. The Catalan Health Institute has subsequently incorporated these recommendations into its own guidelines (6). Current targets include an A1C value ≤7%, blood pressure (BP) values ≤130/80 mmHg, a total cholesterol (TC) value ≤200 mg/dL, and an LDL cholesterol (LDL-C) value ≤100 mg/dL (7).

Despite scientific evidence and the publication of international (8,9) and national guidelines (6,7), adequate control of these patients' health remains beset with challenges. A number of observational studies performed in Spain (10–14) and elsewhere (15–22) have shown that there is a gap between recommendations and daily clinical practice. Several studies have indicated that only 7–9% of diabetic patients achieve optimal control of all CVRFs (11,13,23). The current generalization of electronic clinical records systems in Spain allowed us to access the data of the entire diabetic population registered in the public health care system for our study, unlike previous studies that were based on population samples. The analyses of these data more accurately reflect the actual control of patients with type 2 diabetes in our setting. Previous publications on population registers in other countries have indicated the relevance of these types of data (15–22). Consequently, this cross-sectional study aimed to determine the clinical features and the glycemic and CVRF control of patients with type 2 diabetes in primary care centers of the Catalan Health Institute in Catalonia (Spain).

From the [1]Department of Endocrinology and Nutrition, Diabetes Unit, Hospital Clinic, University of Barcelona, Barcelona, Spain; [2]Primary Care Center La Mina, Gerencia d'Ambit d'Atencio Primaria Barcelona Ciutat, Institut Catala de la Salut, Barcelona, Spain; the [3]Institut Universitari d'Investigacio en Atencio Primaria Jordi Gol, Barcelona, Spain; the [4]Universitat Autònoma de Barcelona, Barcelona, Spain; the [5]Technical Office, Institut Catala de la Salut, Barcelona, Spain; the [6]Public Health Management Agency, Department of Health, Generalitat de Catalunya, Barcelona, Spain; [7]Primary Care Center Raval, Gerencia d'Ambit d'Atencio Primaria Barcelona Ciutat, Institut Catala de la Salut, Barcelona, Spain; the [8]Department of Endocrinology and Nutrition, Hospital Universitari Arnau de Vilanova, Lleida, Spain; and the [9]Department of Endocrinology, Institut de Recerca Biomedica de Lleida, University of Lleida, Lleida, Spain.
Corresponding author: Didac Mauricio, didacmauricio@gmail.com.
Received 31 August 2011 and accepted 27 December 2011.
DOI: 10.2337/dc11-1679
This article contains Supplementary Data online at http://care.diabetesjournals.org/lookup/suppl/doi:10.2337/dc11-1679/-/DC1.

RESEARCH DESIGN AND METHODS—A cross-sectional study that included all patients with type 2 diabetes treated at the Catalan Health Institute was conducted in Catalonia, a Mediterranean region in northeastern Spain. Catalonia has a public health system in which primary care is organized in primary care centers. Every citizen is registered with an individual general practitioner (GP) and a nurse in one of these centers. The main health provider in the region is the Catalan Health Institute, a publicly funded health care system that operates 279 health care centers with >3,500 GPs and 5.8 million patients (80% of the region's population). All GPs in the Catalan Health Institute use the same specific software called ECAP to record clinical information of their patients. Prescribed medication is sold in private pharmacies and registered in a general database (CatSalut database).

Health care and all diagnostic procedures are free of charge to patients. Most patients pay 40% of the cost of medications, which is free for retired, severely ill, or handicapped people. Antidiabetic drugs are almost completely free of charge. Strips for blood glucose monitoring are provided free of charge according to local guidelines.

On average, 70% of patients contacted their primary care team in a given year, although this rate varied according to socioeconomic status. Over three consecutive years, this figure rose to an average of 85% of patients.

The source of information used in this study is the SIDIAP, a computerized database containing anonymized patient records for the 5.8 million people registered with a GP in the Catalan Health Institute. The SIDIAP includes data from ECAP (demographics, consultations with GPs, diagnoses, clinical variables, prescriptions, and referrals), laboratory test results, and medications obtained from the pharmacists (provided by the CatSalut database). The SIDIAP contains all data entered into the ECAP database since it was first introduced in some practices in 1998. In 2005, the system was generalized and used systematically in every Catalan Health Institute practice. Data on laboratory test results and medications sold were available beginning in 2005. Since the SIDIAP database was established, different studies have assessed the validity of its information. This study also contributes to its validation.

All patients aged 31–90 years with a diagnosis of type 2 diabetes (International Classification of Diseases 10 [ICD-10] codes E11 and E14) before 1 July 2009 were included. All variables registered at the end of 2009 were collected. The following data were available for each patient: age; sex; number of visits with the primary care team (physician or nurse) in the previous 12 months; time since diagnosis; and A1C values, using the last value of the previous 15 months. Values expressed in Japan Diabetes Society/Japan Society of Clinical Chemistry (JDS/JSCC) units were converted to the National Glycohemoglobin Standardization Program/Diabetes Control and Complications Trial (NGSP/DCCT) units using the NGSP equation (24).

Data pertaining to chronic complications were also available, including diabetic retinopathy (ICD-10 codes E11.3 and H36.0), diabetic nephropathy (using the most recent value of albumin/creatinine ratio of the study period), and impaired renal function (using the last recorded value of the estimated glomerular filtration rate [GFR] with the MDRD [modification of diet in renal disease] formula in the last 15 months). In addition, data were available for coronary artery disease (ICD-10 codes I20, I21, I22, I23, and I24), stroke (codes I63, I64, G45, and G46), peripheral artery disease (code I73.9), and heart failure (code I50). Information on other CVRFs was available, such as BMI, using the most recent weight value of the last 24 months; blood lipids (TC, LDL-C, and HDL cholesterol [HDL-C]), using the most recent value of the last 15 months; BP (systolic and diastolic BP with the mean value of the last 12 months); and smoking status, according to the last condition registered. CVRF diagnostic criteria were hypertension (ICD-10 code I10) or BP ≥140/90 mmHg, TC ≥250 mg/dL, triglycerides (TGs) ≥150 mg/dL, BMI ≥30 kg/m^2, and a current or former smoking habit.

To assess the degree of control, we used the current local guideline targets: A1C value ≤7%, BP ≤130/80 mmHg, TC ≤200 mg/dL, and LDL-C ≤100 mg/dL for secondary prevention and LDL-C ≤130 mg/dL for primary prevention (7). Furthermore, we assessed the same variables according to the pay-for-performance thresholds established by our institution: A1C <8%, BP ≤140/90 mmHg, and an LDL-C ≤100 mg/dL; however, this LDL-C threshold was used for secondary-prevention patients.

At this stage, we also collected basic data on glucose-lowering medication. For this purpose, drug treatment data for 2009 were obtained from the CatSalut prescription drug pharmacy invoice database. Subjects were considered to have received antidiabetic medication when they had purchased from the pharmacy sufficient medication to cover at least 80% of the total theoretical minimum dose needed during the study period. Patients were considered to be untreated if they had not purchased any drugs. Patients who did not meet the criteria described above, such as those on sporadic treatment or those affected by potential invoicing errors, were considered "unclassifiable". Supplementary Table 1 describes the minimum dose used and the percentage of "unclassifiable" diabetic patients for each antidiabetic drug (<5% of all patients).

We labeled the patient as undergoing double or triple antidiabetic therapy when *1*) the criteria for continuous treatment were met for each of the components and *2*) either a combination or a fixed-dose combination of two or three antidiabetic drugs was given at least for 2 months, according to the prescription drug pharmacy invoices. This study was approved by the Ethics Committee of the Primary Health Care University Research Institute Jordi Gol.

Analysis

We estimated the prevalence of type 2 diabetes stratified by age for binomial events. Means with SDs and proportions were calculated for all variables (clinical characteristics, diabetes-related complications, treatment, and therapeutic goals). We always provide the value over the total number of patients, excluding those with missing values. The Pearson χ^2 test was used to compare categorical data according to sex and age (<65 vs. ≥65 years), and an unpaired Student *t* test was used to compare continuous variables. All statistical analyses were conducted according to the complete-case principle. A two-tailed value of $P < 0.05$ was considered statistically significant. Statistical calculations were performed using Stata Statistical Software Release 11 (StataCorp, LP, College Station, TX).

RESULTS—Of a total population of 3,755,038 individuals between ages 31 and 90 years, 286,791 people were diagnosed with type 2 diabetes, which corresponds to a prevalence of 7.6%. The prevalence increases to 22.4% in patients >70 years of age. Fifty-four percent of the patients were men. Clinical and laboratory characteristics are summarized in Table 1.

During 2009, 96% of patients with type 2 diabetes consulted their GP, and blood tests, which included A1C measurements, were performed on 75% of patients. The mean (SD) A1C value was 7.15 (1.5)%.

Table 1—*Clinical characteristics of the study population*

	Total = 286,791	Men (*n* = 153,987)	Women (*n* = 132,804)
Age (years)	68.2 (11.4)	66.4 (11.3)	70.3 (11.1)
Diabetes duration (years)	6.5 (5.1)	6.2 (4.8)	6.9 (5.3)
A1C (%) (*n* = 214,867; women = 102,063)	7.15 (1.46)	7.16 (1.48)	7.14 (1.44)
Hypertension (%)	77.8	76.3	79.9
Systolic BP (mmHg) (*n* = 243,092; women = 114,606)	137.2 (13.8)	136.9 (13.6)	137.5 (14.0)
Diastolic BP (mmHg) (*n* = 242,942; women = 114,548)	76.4 (8.3)	76.6 (8.5)	76.2 (8.1)
TGs (mg/dL) (*n* = 195,285, women = 91,627)	156.2 (104.9)	158.5 (117.3)	153.5 (88.7)
TC (mg/dL) (*n* = 221,623; women = 105,249)	192.0 (38.6)	186.2 (38.2)	198.4 (38.0)
HDL-C (mg/dL) (*n* = 176,021; women = 83,666)	49.3 (13.2)	46.2 (12.3)	52.7 (13.4)
LDL-C (mg/dL) (*n* = 199,586; women = 95,426)	112.5 (32.4)	109.7 (32.2)	115.6 (32.3)
Obesity (%) (*n* = 202,451; women = 94,777)	45.4	39	52.7
BMI (kg/m^2) (*n* = 202,451; women = 94,777)	29.6 (5.0)	28.8 (4.3)	30.5 (5.6)
Smoking habit (%) (*n* = 218,068; women = 96,716)			
Current smoker	15.4	24.0	6.0
Ex-smoker	18.7	30.9	5.3

Data are mean (SD) or percent. Where indicated, the *n* value denotes the number of study subjects with available data. All comparisons between men and women showed a significant difference, $P < 0.005$.

Fifty-six percent of the patients achieved the optimal A1C target (≤7%), a result more frequently observed in patients >65 years of age ($P < 0.001$). Eighty-five percent of the patients had at least one BP measurement during the study period. Of these patients, 65% had a systolic BP measurement <140 mmHg, and 36.2% were <130 mmHg, whereas 92.5% had a diastolic BP measurement <90 mmHg, with up to 69.5% of the patients <80 mmHg. Total cholesterol was measured in 77.3% of patients, and overall, women had higher values than men. Ninety-three percent had TC values <250 mg/dL, and 61.3% had values <200 mg/dL. HDL-C values were >40 mg/dL in 79.04% of men and >50 mg/dL in 70.1% of women. TG values were <200 mg/dL in 79.7% of patients with type 2 diabetes, with a mean value of 156.2 mg/dL. Obesity was more frequent in women, whereas smoking was more frequent in men ($P < 0.005$ for both comparisons). The control of target CVRFs is summarized in Table 2. The complete set of data for all three main control criteria (A1C, LDL-C, and BP) was available for 179,915 (63%) patients. Of the patients on primary prevention, only 12.9% had met all targets (A1C ≤7%, BP ≤130/80 mmHg, and LDL-C <130 mg/dL), whereas in patients on secondary prevention, this number was similar at 12.1% (A1C ≤7%, BP ≤130/80 mmHg, and LDL-C <100 mg/dL).

Chronic complications of the patients with type 2 diabetes are shown in Table 3. Diabetic retinopathy, impaired renal function (but not albuminuria), and ischemic heart disease were more frequent in women than in men ($P < 0.001$ for all comparisons).

With regard to antidiabetic treatment, we analyzed only those patients considered

Table 2—*Results of individual or combined (primary and secondary cardiovascular prevention) treatment goals achieved for the total population and also stratified according to sex and age*

	Total	Men	Women	Age <65 years	Age ≥65 years
A1C ≤7% (*n* = 214,867; women = 102,063; ≥65 years = 139,161)	56.1	55.8	56.5	51.8	58.5
A1C ≤8%	79.6	79.1	80.1	74.2	82.5
A1C >10%	5	5.2	4.7	8	3.3
BP ≤130/80 mmHg (*n* = 242,842; women = 114,493; ≥65 years = 159,838)	31.7	32.0	31.4	33.3	30.9
BP ≤140/90 mmHg	63.5	63.5	63.1	66.6	61.9
TC <200 mg/dL (*n* = 221,623; women = 91,627; ≥65 years = 126,014)	61.3	67.3	54.6	55.4	63.4
LDL-C <100 mg/dL (*n* = 199,586; women = 95,426; ≥65 years = 130,529)	37.9	41.3	34.2	32.8	40.6
LDL-C <130 mg/dL	72.4	75.2	69.4	67.2	75.2
TGs <150 mg/dL (*n* = 195,285; women = 91,627; ≥65 years = 126,014)	39.6	38.8	40.4	47.2	35.4
BMI <30 kg/m^2 (*n* = 202,451; women = 94,777; ≥65 years = 130,851)	56.4	61.0	47.3	48.5	57.9
Nonsmoker (*n* = 195,632; women = 96,716; ≥65 years = 138,247)	65.9	45.1	88.8	51.2	73.7
Primary prevention: A1C ≤7%, BP ≤130/80 mmHg, and LDL-C <130 mg/dL (*n* = 145,605; women = 71,246; ≥65 years = 91,689)	12.9	13.3	12.7	12.2	13.3
Secondary prevention: A1C ≤7%, BP ≤130/80 mmHg, and LDL-C <100 mg/dL (*n* = 34,310; women = 12,200; ≥65 years = 27,386)	12.1	13.3	9.9	11.9	12.1

Dara are percentages. The primary and secondary prevention treatment goals were defined according to the local guidelines. The percentages are from the study subjects with available data for each variable. All variables showed significant differences between sex ($P < 0.005$) and age groups ($P < 0.001$).

Table 3—*Prevalence of diabetes-related micro- and macroangiopathic complications, as assessed by ICD code records and laboratory data*

	Total = 286,791	Men (n = 153,987)	Women (n = 132,804)
Retinopathy (%)	5.8	5.6	6.1
Impaired renal function (%) (n = 174,571; women = 82,440)			
GFR: 30–59 mL/min	18.6	14.5	23.9
GFR: 15–30 mL/min	1.2	0.9	1.5
GFR <15 mL/min	0.2	0.3	0.2
Albuminuria (%) (n = 171,063; women = 80,983)			
Microalbuminuria	14.9	18.4	11.1
Macroalbuminuria	1.8	2.4	1.2
Ischemic heart disease (%)	11.3	14.3	7.8
Cerebral vascular disease (%)	6.5	7.1	5.9
Peripheral vascular disease (%)	2.9	4.2	1.5

Where indicated, the n value denotes the number of study subjects with available data. GFR was assessed using the MDRD formula. Micro- and macroalbuminuria were defined as an albumin/creatinine ratio of 30–300 and >300 mg/g, respectively. All comparisons between men and women showed a significant difference, $P < 0.001$.

to be taking continuous medication. Twenty-two percent of all patients studied were managed by lifestyle measures. Most medicated patients were prescribed oral antidiabetic treatments: 46.9, 22.9, and 2.8% were taking one, two, and three antidiabetic drugs, respectively. A total of 23.4% of the patients on continuous antidiabetic drug therapy received insulin, ~10% as monotherapy, whereas 13.4% combined insulin with oral agents.

CONCLUSIONS—In Spain, where the current prevalence of diabetes is 13.8% (of which 6% corresponds to unknown diabetes) (1), type 2 diabetic patients are mainly treated by the primary care public health system. In recent years, several studies have analyzed the characteristics and degree of control of patients with type 2 diabetes in our country, but these studies were characterized by great differences in methods and sample size (2,10–14,23,25). The major strength of our study is the inclusion of every patient with type 2 diabetes from a total population database of 3,755,038 people over age 30. With data from 286,791 diabetic patients and a prevalence of diabetes of 7.6%, this is the largest study ever undertaken in Europe. The observed prevalence of type 2 diabetes is close to the reported prevalence of 7.8% for known diabetes in the Spanish population (1), even though our study analyzed only type 2 diabetes in people >30, with the main purpose to avoid the inclusion of patients with type 1 diabetes. Although we did not have access to the data of every patient in Catalonia, we considered this prevalence to be a precise estimate because the Catalan Health Institute provides health care to 80% of the Catalan population (7 million patients in 2009). Moreover, 96% of the patients with type 2 diabetes had contacted the health care system at least once during the year of study. The frequent use and quality of this registry make the SIDIAP an ideal reference database for surveillance of the prevalence and risk factor control of type 2 diabetes in our region. With regard to methodology, the accuracy of the results is strengthened by the existing link between primary care clinical records and prescriptions obtained from the pharmacy database, thus reducing the possible gap between physician prescription and patient adherence.

Study subject characteristics, such as mean age and degree of obesity, were similar to previously published data from other Spanish studies (34–50% patients were obese), though we found a slightly higher proportion of men and a slightly shorter duration of the disease (6.5 years). This could have been the result of the computerization of clinical records that took place between 2000 and 2004 at our institution, which required active registration of the date of diagnosis by the health care professional. The registration in some cases could have been set by default as the date of the first visit.

Likewise, the degree of glycemic control, as measured by the mean A1C at a cutoff of 7.15%, is comparable to that of other studies that have found values between 6.8 and 7.3%. However, the proportion of patients with good control (56.1% with A1C ≤7%) was lower than in other Spanish studies, most likely because of the previous lack of standardization of A1C measurement. The lack of A1C standardization affects the proportion of patients with good control. In fact, the Japanese kit (JDS/JSCC method) yields lower values of A1C than the DCCT kit, and standardization has led to a slight increase in the A1C values (6.85 vs. 7.15%) and a decrease in the percentage of patients with A1C ≤7% (65 vs. 56.1%). We considered this difference to be the main reason for the differences observed between Spanish studies and those in other countries, such as the U.S., where DCCT values were more widely used. Indeed, in the American study of Saaddine et al. (16), carried out between 1988 and 2002, only 42.3% of patients had A1C values ≤7%, whereas in 2005, a study in Italy showed that 59.9% of patients had A1C values ≤7% (19), a result very similar to ours. This relatively good result can be explained by early diagnosis and treatment aimed at achieving the control targets. The implementation of a target-based management system for chronic diseases includes financial incentives for Catalan Health Institute professionals, who receive an annual financial incentive based on the percentage of patients that achieve glycemic (55% with A1C <8%), hypertension (55% with BP <140/90 mmHg), and lipid control (40% with LDL-C <100 mg/dL) during the previous year.

In our current study, 79.6% of the patients had A1C values ≤8%, a result above the proposed target. The effect of pay for performance on quality in primary care was recently evaluated in England (20). In that study, the proportion of patients who achieved the target A1C value (≤7.5%) increased from 59.1 to 66.7%, the proportion that achieved the target BP (≤145/85 mmHg) increased from 70.9 to 80.2%, and the proportion that achieved the target TC value (≤5 mmol/L) increased from 72.6 to 83.6%.

According to the data published by the Gedaps group in Catalonia, glycemic control has improved progressively, as demonstrated by A1C values that initially averaged 7.7% in 1993 and later reached 6.8% in 2007 (14). Because A1C values in the Gedaps study were not standardized to DCCT values, the 2007 result was actually similar to our result, which was 6.85% before standardization. Comparable positive trends have been observed in certain American Health Maintenance

Organizations, such as Kaiser Permanente, where the mean A1C value decreased from 8.3% in 1994 to 6.9% in 2003, and the mean LDL-C value decreased from 132 mg/dL in 1995 to 97 mg/dL in 2003 (22). The average LDL-C concentration in our study was 112.5 mg/dL, and 37.9% of patients had LDL-C ≤100 mg/dL.

The mean values of BP control were similar to those observed in the Gedaps study in 2007 (137/77 mmHg and 66% of patients with BP ≤140/90 mmHg) (14), better than those published in other Spanish studies (10,12,25). However, the American Behavioral Risk Factor Surveillance System (BRFSS) study (70.3% of patients with systolic BP <140 mmHg) (16) and the British pay-for-performance study (80.2% with BP ≤145/85 mmHg) (20) achieved better control values than those observed in our study.

The results regarding chronic complications, such as macroangiopathy, are similar to those observed in other Spanish studies (14), whereas microvascular complications were probably underreported. We considered the impaired renal function values (MDRD <60 mL/min, 20%) reliable because they have been calculated by the MDRD formula, though this prevalence is slightly lower than that of other studies (14).

In general, the percentage of patients on pharmacological treatment (78%) was higher than that of other studies (15,17,18), even when only patients who were receiving continuous treatment with antidiabetic drugs were considered. Most patients receiving medication were managed with oral antidiabetic treatment (72.6%), whereas 23.4% were treated either with insulin alone or insulin combined with oral agents.

The current study has several limitations. The main limitation of this cross-sectional study is the missing data for a significant proportion of the patients studied. In some instances, the data were not recorded by the health care professionals, but in other cases, the heterogeneity of the variables recorded in the different centers precluded their use in the analysis. Although the data are consistent with previous findings, there is still a risk of bias in the results of this study, as underdiagnosis of type 2 diabetes or other associated conditions and underrecording of data may have occurred. These are common limitations of current primary-care, electronic-record databases and justify additional validation studies using external databases, the development of internal control algorithms, and the comparison of the results to other, similar studies. The present results are comparable to those of previous publications. There is a need for further improvement of the quality of the data obtained in studies such as ours to strengthen their validity. Finally, some relevant diabetic patient–oriented outcomes, such as the mortality and quality of life, could not be addressed in this study. However, a future study on cardiovascular morbidity and mortality in this population is warranted.

The availability of the data on real-life clinical practice at the primary care level may have important implications for diabetes care. The information obtained should allow the current clinical practice to be assessed in terms of the outcomes of the process and the results of diabetes care. This possibility has several implications that should ultimately lead to improved patient care, including monitoring of diabetes indicators, identification of practice issues to be improved, potential introduction of changes in the health care plans, identification of appropriate targets for pay-for-performance incentives, and allocation of resources for this type of registry as a tool to aid decisions to improve diabetes care.

In conclusion, the results of this study, with regard to A1C value, dyslipidemia, and BP control in patients with type 2 diabetes are similar to those reported in other studies conducted in Spain and elsewhere. These results may be explained by early detection and adequate treatment by primary care professionals, which is enhanced by the target-based management system that includes financial incentives. The information provided by the current study might lead to the implementation of strategies to improve clinical care of type 2 diabetic patients. However, further improvement is necessary, and the SIDIAP database might be an optimal surveillance reference system for the prevalence and control of the disease. The impact of late complications in patients with type 2 diabetes deserves further analysis. To reduce the burden of this disease, policies that promote the optimal management of this condition and associated CVRFs should be implemented.

Acknowledgments—The Catalan Diabetes Association, the Catalan Health Department, and part of an unrestricted grant provided by sanofi-aventis Spain supported this study, as well as the Network of Preventive Activities and Health Promotion in Primary Care (redIAPP) granted by the Instituto de Salud Carlos III (RD06/0018). No other potential conflicts of interest relevant to this article were reported.

I.V., M.M.-C., and R.M. wrote the manuscript and contributed to discussion. E.H. and F.F. researched the data and contributed to discussion. M.R. and C.C. contributed to discussion. J.F.-N., B.B., and D.M. designed and conducted the study, reviewed and edited the manuscript, and contributed to discussion. D.M. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

This study was possible thanks to the commitment of physicians and nurses working in the Catalan Health Institute to provide optimal care to patients with diabetes.

References

1. Soriguer F, Goday A, Bosch-Comas A, et al. Prevalence of diabetes mellitus and impaired glucose regulation in Spain: the Diabetes Study. Diabetologia 2011;55:88–93
2. Mata M, Antoñanzas J, Tafalla M, Sanz P. The cost of type 2 diabetes in Spain: the CODE-2 study. Gac Sanit 2002;16:511–520 [in Spanish]
3. American Diabetes Association. Implications of the United Kingdom Prospective Diabetes Study. Diabetes Care 2002;25:S28–S32
4. Holman RR, Paul SK, Bethel MA, Matthews DR, Neil HAW. 10-year follow-up of intensive glucose control in type 2 diabetes. N Engl J Med 2008;359:1577–1589
5. Gaede P, Lund-Andersen H, Parving HH, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. N Engl J Med 2008;358:580–591
6. Abordatge de la diabetes mellitus tipus 2 [article online], 2009. Available from http://www.gencat.cat/ics/professionals/guies/docs/guia_diabetis.pdf. Accessed 11 August 2011
7. Cano JF, Franch J, Mata M; Grup d'Estudi de la Diabetes a l'Atenció Primària de Salut (GEDAPS). *Guía Para el Tratamiento de la Diabetes Tipo 2 en Atención Primaria*. Madrid, Harcourt Ed, 2004.
8. American Diabetes Association. Standards of medical care in diabetes—2010. Diabetes Care 2010;33:S11–S61
9. IDF Clinical Guidelines Task Force. Global Guideline for Type 2 Diabetes: recommendations for standard, comprehensive, and minimal care. Diabet Med 2006;23:579–593
10. Benito-López P, García-Mayor R, Puig-Domingo M, et al.; MIDIA. Pathological characteristics of patients with diabetes mellitus type 2, in Spanish primary care. Rev Clin Esp 2004;204:18–24 [in Spanish]
11. Arroyo J, Badía X, de la Calle H, et al.; Grupo pro-Star. Management of type 2 diabetic patients in primary care in Spain. Med Clin (Barc) 2005;125:166–172 [in Spanish]
12. Orozco-Beltrán D, Gil-Guillen VF, Quirce F, et al.; Collaborative Diabetes Study Investigators. Control of diabetes and cardiovascular

risk factors in patients with type 2 diabetes in primary care. The gap between guidelines and reality in Spain. Int J Clin Pract 2007;61:909–915
13. Franch Nadal J, Artola Menéndez S, Diez Espino J, Mata Cases M; en representación de la Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud. The evolution of quality care indicators of patients with type 2 diabetes in the Spanish primary care (1996-2007). The RedGEDAPS quality of care program . Med Clin (Barc) 2010;135:600–607 [in Spanish]
14. Mata-Cases M, Benito-Badorrey B, Roura-Olmeda P, Coll de Tuero G, Pepió-Vilaubí JM, Franch-Nadal J; Gedaps (Primary care Group for the study of Diabetes) of the Catalan Society of Family & Community Medicine. Fifteen years of improvement in process and outcome indicators in the management of type 2 diabetes mellitus in primary care centers in Catalonia, Spain (Abstract). Diabetologia 2010;53:407S
15. Rothe U, Müller G, Schwarz PE, et al. Evaluation of a diabetes management system based on practice guidelines, integrated care, and continuous quality management in a Federal State of Germany: a population-based approach to health care research. Diabetes Care 2008;31:863–868
16. Saaddine JB, Cadwell B, Gregg EW, et al. Improvements in diabetes processes of care and intermediate outcomes: United States, 1988-2002. Ann Intern Med 2006; 144:465–474
17. Eliasson B, Cederholm J, Nilsson P, Gudbjörnsdóttir S; Steering Committee of the Swedish National Diabetes Register. The gap between guidelines and reality: type 2 diabetes in a National Diabetes Register 1996-2003. Diabet Med 2005;22:1420–1426
18. Cooper JG, Claudi T, Jenum AK, et al. Quality of care for patients with type 2 diabetes in primary care in Norway is improving: results of cross-sectional surveys of 33 general practices in 1995 and 2005. Diabetes Care 2009;32:81–83
19. Club Diabete Sicili@. Five-year impact of a continuous quality improvement effort implemented by a network of diabetes outpatient clinics. Diabetes Care 2008;31: 57–62
20. Vaghela P, Ashworth M, Schofield P, Gulliford MC. Population intermediate outcomes of diabetes under pay-for-performance incentives in England from 2004 to 2008. Diabetes Care 2009;32:427–429
21. Morris AD, Boyle DI, MacAlpine R, et al.; DARTS/MEMO Collaboration. The diabetes audit and research in Tayside Scotland (DARTS) study: electronic record linkage to create a diabetes register. BMJ 1997; 315:524–528
22. Sperl-Hillen JM, O'Connor PJ. Factors driving diabetes care improvement in a large medical group: ten years of progress. Am J Manag Care 2005;11(Suppl.):S177–S185
23. De la Calle H, Costa A, Díez-Espino J, Franch J, Goday A. Evaluation on the compliance of the metabolic control aims in outpatients with type 2 diabetes mellitus in Spain. The TranSTAR study. Med Clin (Barc) 2003;120:446–450 [in Spanish]
24. Hoelzel W, Weycamp C, Jeppson JO, et al.; IFCC Working Group on HbA1c Standardization. IFCC reference system for measurement of hemoglobin A1c in human blood and the National Standarization Schemes in the United States, Japan and Sweden: a method-comparison study. Clin Chem 2004; 50:166–174
25. Liebl A, Mata M, Eschwège E; CODE-2 Advisory Board. Evaluation of risk factors for development of complications in Type II diabetes in Europe. Diabetologia 2002; 45:S23–S28

4.3 Tercer Artículo

Diferencia en el control cardiometabólico de la Diabetes tipo 2 según el género y la presencia de enfermedad cardiovascular: Resultados del studio eControl. ***International Journal of Endocrinology, 2014.***

Hindawi Publishing Corporation
International Journal of Endocrinology
Volume 2014, Article ID 131709, 11 pages
http://dx.doi.org/10.1155/2014/131709

Research Article

Differences in the Cardiometabolic Control in Type 2 Diabetes according to Gender and the Presence of Cardiovascular Disease: Results from the eControl Study

Josep Franch-Nadal,[1,2] Manel Mata-Cases,[2,3] Irene Vinagre,[4] Flor Patitucci,[1] Eduard Hermosilla,[2] Aina Casellas,[2] Bonaventura Bolivar,[2] and Dídac Mauricio[2,5]

[1] *Primary Health Care Center Raval, Gerència d'Àmbit d'Atenció Primària Barcelona Ciutat, Institut Catala de la Salut, Avenida Drassanes 17-21, 08001 Barcelona, Spain*
[2] *Unitat de Suport a la Recerca Barcelona Ciutat, Institut Universitari de Investigació en Atenció Primària Jordi Gol (IDIAP Jordi Gol), Avenida Gran Via de les Corts Catalanes, 587 Àtic, 08007 Barcelona, Spain*
[3] *Primary Health Care Center La Mina, Gerència d'Àmbit d'Atenció Primària Barcelona Ciutat, Institut Catala de la Salut, C/Mar s/n, Sant Adrià de Besòs, 08930 Barcelona, Spain*
[4] *Department of Endocrinology and Nutrition, Diabetes Unit, Hospital Clinic, University of Barcelona, C/Villarroel 170, 08036 Barcelona, Spain*
[5] *Department of Endocrinology & Nutrition, Health Sciences Research Institute and Hospital Universitari Germans Trias i Pujol, Carretera Canyet s/n, 08916 Badalona, Spain*

Correspondence should be addressed to Josep Franch-Nadal; josep.franch@gmail.com and Dídac Mauricio; didacmauricio@gmail.com

Received 4 July 2014; Accepted 7 September 2014; Published 21 September 2014

Academic Editor: Alexandra Kautzky-Willer

The objective of this cross-sectional study was to assess differences in the control and treatment of modifiable cardiovascular risk factors (CVRF: HbA1c, blood pressure [BP], LDL-cholesterol, body mass index, and smoking habit) according to gender and the presence of cardiovascular disease (CVD) in patients with type 2 diabetes mellitus (T2DM) in Catalonia, Spain. The study included available data from electronic medical records for a total of 286,791 patients. After controlling for sex, age, diabetes duration, and treatment received, both men and women with prior CVD had worse cardiometabolic control than patients without previous CVD; women with prior CVD had worse overall control of CVRFs than men except for smoking; and women without prior CVD were only better than men at controlling smoking and BP, with no significant differences in glycemic control. Finally, although the proportion of women treated with lipid-lowering medications was similar to (with prior CVD) or even higher (without CVD) than men, LDL-cholesterol levels were remarkably uncontrolled in both women with and women without CVD. The results stress the need to implement measures to better prevent and treat CVRF in the subgroup of diabetic women, specifically with more intensive statin treatment in those with CVD.

1. Introduction

The prevalence rates of diabetes mellitus (DM) have significantly increased during the last years, accompanied by a parallel rise in complications and deaths from the disease [1, 2]. The worldwide prevalence in 2013 has been estimated to be 8.3%, and it is expected to be about 1 adult in 10 by 2035, which represents a substantial 55% increase [3, 4]. A recent population-based survey conducted in Spain reported a global prevalence of DM of 13.8% in adult subjects, and 43.5% of them were unaware of their disease, thus corresponding to a prevalence of unknown DM of 6% [5].

People with type 2 diabetes mellitus (T2DM) are at increased risk of cardiovascular complications such as coronary artery disease, stroke, or peripheral vascular disease [6, 7]. In turn, these complications are associated with increased

morbidity and mortality and have a detrimental effect on health-related quality of life [8]. Current available evidence indicates that, in terms of risk reduction of cardiovascular and microvascular complications, control of blood pressure and lipid levels is more effective than glucose control [9–11]. Additionally, type 2 diabetic patients with clinical cardiovascular disease (CVD) are at a higher risk of a recurrent cardiovascular event [12, 13]. However, several studies have shown that, in clinical practice, secondary prevention strategies in diabetic patients with CVD are associated with a suboptimal cardiometabolic control [11, 14].

Systematic reviews of the literature have reported that the excess relative risk of CVD attributable to diabetes is 2-fold in men and 3- to 4-fold in women [15, 16], and this has been further confirmed by several meta-analyses [17–19]. Some authors have postulated that diabetes prompts the loss of the natural hormonal protection against CVD in women [20, 21], but several factors that may explain this excess risk in women relative to men have been identified so far [22–25], and they mainly include a low risk perception by health care providers [26]; an increased time to proper medical care from the onset of symptoms; a lower predictive capability of certain diagnostic tests (e.g., stress test); a differential drug response among women to some medications such as aspirin [27] or statins [28], which decreases their effectiveness; and worse clinical outcomes after therapeutic procedures [29].

Cross-sectional studies have reported that the control of cardiovascular risk factors (CVRF) is poorer among diabetic women relative to diabetic men of the same age [30–32]. Moreover, the follow-up of the population in the National Health and Nutrition Examination Surveys (NHANES) has shown that, for the past years, there has been an overall decline in mortality rates due to CVD, but not in the subgroup of diabetic women [33].

On the other hand, studies derived from the analysis of large databases have proven to be useful for evaluating cardiometabolic control, associated risk factors, long-term complications, and other clinically relevant aspects of T2DM [34–37].

The aim of the present population-based study was to assess differences in the degree of control and treatment of modifiable CVRF according to gender and CVD in patients with T2DM in Catalonia, Spain.

2. Materials and Methods

2.1. Design. This cross-sectional study includes all type 2 diabetes subjects visiting any of the 274 primary care centres pertaining to the Catalan Health Institute (ICS) in Catalonia, a northeastern region of Spain, which takes care of a population of about 5.8 million patients (80% of the total population for the region).

The data for the present study (eCONTROL) were extracted from SIDIAP (Information System for the Development of Research in Primary Care; SIDIAP) [38], a database of electronic medical records started in 2006. Methodological details of the study of diabetes mellitus using this database have been described in previous publications [36, 39]. Briefly, SIDIAP contains anonymized longitudinal patient information obtained through use of specific software (eCAP) implemented in all primary care centers in Catalonia and includes sociodemographic characteristics, morbidity (by means of International Classification of Diseases codes; ICD-10), clinical and lifestyle variables, specialist referrals, and results of laboratory tests and treatments based on prescription- and pharmacy-invoicing data provided by the CatSalut general database.

2.2. Data Extraction. Data from patients attended before July 1, 2009, aging 31 to 90 years, and with a diagnosis of type 2 diabetes (ICD-10 codes E11 or E14) were extracted from the SIDIAP database [36]. Available variables (registered up to the end of 2009) included age; gender; time since diagnosis; estimated glomerular filtration rate (eGFR) using the Modified Diet in Renal Disease (MDRD) formula; standardized glycated haemoglobin (HbA1c) values, using the most recent value of the preceding 15 months; presence of cardiovascular disease, including coronary artery disease (ICD-10 codes I20, I21, I22, I23, or I24), stroke (ICD-10 codes I63, I64, G45, or G46), and peripheral artery disease (ICD-10 code I73.9); risk factors, including body mass index (BMI) (most recent value in the last 24 months), cholesterol levels (total, low-density lipoproteins or LDL-cholesterol, and high-density lipoproteins or HDL-cholesterol; most recent value in the last 15 months), blood pressure (BP) (systolic and diastolic mean value in the last 12 months), smoking status (most recent value); and data on prescribed glucose-lowering, lipid-lowering, and antihypertensive and antithrombotic medications.

Diagnostic criteria for CVRF were HbA1c > 7%; hypertension (blood pressure > 140/90 mmHg); hypercholesterolemia (total cholesterol > 250 mg/dL); hypertriglyceridemia (triglycerides > 150 mg/dL); obesity (BMI > 30 kg/m^2); and current or former smoking habit. Treatment goals for patients with and without a history of CVD were based on local guidelines [40, 41]; without CVD prevention: HbA1c ≤ 7%, BP ≤ 140/90 mmHg, and LDL-cholesterol ≤ 130 mg/dL; with CVD prevention: HbA1c ≤ 7%, BP ≤ 140/90 mmHg, and LDL-cholesterol ≤ 100 mg/dL.

This study was approved by the Ethics Committee of the Primary Health Care University Research Institute (IDIAP) Jordi Gol.

2.3. Statistical Analysis. Descriptive analyses were summarized by mean and standard deviation for continuous variables and percentages for categorical variables. Comparisons by gender and presence of CVD were performed with Pearson chi-square tests for categorical variables and analysis of variance (ANOVA) for continuous variables. We applied multilevel logistic regression models to identify the factors associated with good cardiometabolic control of CVRFs. Only those variables with a statistically significant effect ($P < 0.05$) in the univariate analyses were retained for the multivariate model. Analyses were performed stratifying according to the presence of CVD, and odds ratios (OR) and 95% confidence intervals (95% CI) were adjusted for gender, diabetes duration, and treatment as confounding variables. Statistical calculations were performed using StataCorp 2009

(Stata Statistical Software: Release 11. College Station, TX: StataCorp, LP).

3. Results

The study included data from a total of 286,791 patients with T2DM (153,987 men and 132,804 women). Overall, 18.4% of the patients ($N = 52{,}665$) had a previous history of any CVD, which was more frequently reported among men (22.3% versus 13.8%).

In the overall population, all studied variables showed significant differences between men and women; women were in average older than men, had a longer duration of the disease, and had slightly worse cardiometabolic control than men, with higher blood pressure levels (mean 137.5/76.2 mmHg versus 136.9/76.6 mmHg; $P < 0.005$), higher LDL-cholesterol levels (mean 115.6 mg/dL versus 109.7 mg/dL; $P < 0.005$), and higher average BMI (mean 30.5 versus 28.8; $P < 0.005$), but slightly better control of the percentage of HbA1c than men (7.1% versus 7.2%; $P < 0.005$) (Table 1). Moreover, triglyceride levels were lower in women (mean 153.5 mg/dL versus 158.5 mg/dL; $P < 0.005$), and there were far more nonsmokers among diabetic women (88% versus 43.5%; $P < 0.005$).

3.1. Cardiometabolic Control of T2DM and Degree of Control of CVRF according to History of CVD and Gender. The stratified analysis according to history of CVD showed that men with prior CVD had significantly better control of BP, weight, lipid profile, and smoking than men without a history of CVD (all variables $P < 0.001$) (Table 1). Additionally, there were no clinically significant differences with regard to glycemic control between the groups ($P = 0.058$). However, this pattern was strikingly different among women: those with previous CVD had significantly higher HbA1c (7.2% versus 7.1%; $P = 0.003$), systolic BP (mean 138 mmHg versus 137.5 mmHg; $P < 0.001$), and triglyceride values (156.3 mg/dL versus 153.1 mg/dL; $P < 0.001$) than women without a history of CVD.

When considering the adequate treatment goals of CVRFs by gender, women showed worse overall control than men ($P < 0.005$ for all variables except for smoking); this was seen both in subjects with no previous CVD and in those with history of any CVD ($P < 0.001$ for all studied variables) (Table 1 and Figure 1). The greatest differences compared with men were seen in the levels of LDL-cholesterol and in weight, while differences in BP were less evident, and the percentage of patients with HbA1c ≤ 7% was slightly higher among women without CVD (56.8% versus 56%, $P < 0.05$) and lower in women with CVD (54.6% versus 55%, $P < 0.05$). In accordance, the degree of composite control of CVRFs, that is, simultaneously taking into account hyperglycemia (HbA1C ≤ 7%, BP ≤ 140/90 mmHg) and LDL-cholesterol levels (LDL-cholesterol ≤ 130 mg/dL in patients without previous CVD and ≤100 mg/dL in those with prior CVD), was significantly worse among women: 25.1% of women without CVD were in good control compared to 27% of men, and among those with prior CVD, 17.7% of women had an optimal composite control versus 22.8% of men ($P < 0.005$ in both cases). Moreover, the proportion of patients with good composite control of CVRFs was lower among those with prior CVD, and this was true for both men and women: 17.7% of women with prior CVD were in good control versus 21.5% without CVD ($P < 0.001$), and 22.8% of men with prior CVD were in good control versus 27% without CV ($P < 0.001$).

3.2. Multivariate Analysis of Good CVRF Control according to Gender and CVD. After adjusting for gender (woman), age, diabetes duration, and treatment received, multivariate analysis showed that men in secondary prevention after CVD had better control of all risk parameters except for smoking. In the case of prevention of CVD, women still had better control over smoking than men, but also better control of their BP, whilst there were no clinically significant differences in glycemic control between genders (Table 2), and women remained worse than men at controlling weight and LDL-cholesterol levels.

3.3. Degree of CVRF Control in Different CVDs. Study of the different macrovascular complications, specifically coronary heart disease (CHD), stroke, or peripheral arterial disease (PAD), showed that the proportion of women with good control of target CVRFs, namely, HbA1c ≤ 7%, BP ≤ 140/90 mmHg, and BMI ≤ 30 Kg/m^2, and also lipid profiles in subjects with or without prior CVD was lower than men irrespective of the type of CVD ($P < 0.001$ in all cases) (Table 3).

3.4. Treatment of CVRFs in Patients with and without CVD according to Gender. We further studied whether treatment for the different CVRFs differed between genders in the presence/absence of prior CVD (Table 4). Among the subset of patients without a history of CVD, women had higher rates of prescribed glucose-lowering, antihypertensive, and lipid-lowering drugs than men (75% versus 73.3%, 70.8% versus 59.9%, and 47.6% versus 43.1%, resp.) and similar use of antiplatelet agents (27.6% versus 28.3%). However, in the subgroup of patients with a history of CVD, differences in the use or intensity of glucose-lowering and lipid-lowering treatments were not clinically relevant between genders, but women used less antiplatelet agents (71.8% versus 77.5%) and more antihypertensive agents (88.4% versus 86.4%) than men. Of note was that oral glucose-lowering agents in mono- or combined therapy were less often prescribed to women than to men in favor of a greater use of insulin therapy, either alone or combined with oral glucose-lowering drugs.

4. Discussion

Gender differences among the diabetic population include disparities in adherence to treatment [42], in control of cardiometabolic parameters and risk of CVD [30, 31, 43], and also in the therapeutic management of cardiovascular risk factors [25, 44, 45].

The prevalence rates of T2DM and CVD in our study were higher among men, which is in line with previous population-based studies [30, 46–48], although rates vary depending on the age range, country, and definition of CVD.

Table 1: Demographic, clinical characteristics, and degree of cardiometabolic control by gender and presence of CVD*.

	All patients		CVD		No CVD	
	Men $N = 153{,}987$	Women $N = 132{,}804$	Men $N = 34{,}283$	Women $N = 18{,}382$	Men $N = 119{,}704$	Women $N = 114{,}422$
CV risk factors						
Age, mean (SD), years	66.4 (11.3)	70.3 (11.1)	70.9 (9.6)	75.6 (8.7)	65.1 (11.4)	69.4 (11.2)
Diabetes duration, mean (SD), years	6.2 (4.8)	6.9 (5.3)	7.3 (5.5)	8.3 (6.4)	5.9 (4.5)	6.7 (5.1)
Hypertension, %	58.6	69.7	69.5	81.5	55.4	67.8
Systolic BP, mean (SD), mmHg	136.9 (13.6)	137.5 (14)	136.1 (14.3)	138 (14.7)	137.2 (13.4)	137.5 (13.8)
Diastolic BP, mean (SD), mmHg	76.6 (8.5)	76.2 (8.1)	73.8 (8.4)	73.6 (8.2)	77.5 (8.3)	76.6 (8)
Diabetic retinopathy, %	5.6	6.1	8.3	10.9	4.8	5.4
Diabetic nephropathy, %	20.7	12.3	26.7	18.3	19	11.3
BMI, mean (SD), kg/m^2	28.8 (4.3)	30.5 (5.6)	28.6 (4.1)	30.1 (5.4)	28.9 (4.3)	30.6 (5.6)
HbA1c, %	7.2 (1.5)	7.1 (1.4)	7.1 (1.4)	7.2 (1.4)	7.2 (1.5)	7.1 (1.4)
Total cholesterol, mean (SD), mg/dL	186.2 (38.2)	198.4 (38)	171.5 (36.9)	185.6 (39.4)	190.5 (37.5)	200.4 (37.3)
HDL-cholesterol, mean (SD), mg/dL	46.2 (12.3)	52.7 (13.4)	44.4 (11.8)	50.2 (12.9)	46.7 (12.4)	53.1 (13.4)
LDL-cholesterol, mean (SD), mg/dL	109.7 (32.2)	115.6 (32.3)	97.1 (30.7)	104.4 (32.5)	113.6 (31.6)	117.4 (31.9)
Triglycerides, mean (SD), mg/dL	158.5 (117.3)	153.5 (88.7)	153.4 (106.8)	156.3 (91.8)	160 (120.3)	153.1 (88.2)
Smoking status, %						
Non smokers	43.5	88	42.4	90.1	43.8	87.6
Current smokers	23.9	6.2	18.1	3.8	25.6	6.6
Ex-smoker	32.6	5.8	39.5	6.1	30.6	5.8
Degree of CVRF control						
HbA1c ≤ 7%, %	55.8	56.5	55	54.6	56	56.8
BMI ≤ 30 kg/m^2, %	61	47.3	62.5	49.7	60.6	46.9
BP ≤ 140/90 mmHg, %	63.9	63.1	65.5	62.1	63.5	63.2
LDL-cholesterol ≤ 130 mg/dL, % (PP)	75.2	69.4	86.3	80.2	71.8	67.7
LDL-cholesterol ≤ 100 mg/dL, % (SP)	41.3	34.2	58.8	49.2	35.9	31.7
HbA1c ≤ 7% + BP ≤ 140/90 mmHg + LDL ≤ 130 mg/dL, %	28.5	25.6	33.1	28.9	27.0	25.1
HbA1c ≤ 7% + BP ≤ 140/90 mmHg + LDL ≤ 100 mg/dL, %	15.7	12.4	22.8	17.7	13.5	11.5

*All variables showed significant differences between sexes ($P < 0.005$) and between CVD and no CVD in both men and women ($P < 0.001$), except for HbA1c: $P = 0.058$ in men and $P = 0.003$ in women. BMI: body mass index; BP: blood pressure; CVD: cardiovascular disease; PP: primary prevention; SD: standard deviation; SP: secondary prevention.

Table 2: Multivariate analysis on the degree of control of CVRFs stratified according to the presence of CVD.

	CVD		No CVD	
	OR[a] (95% CI)*	*P* value	OR[a] (95% CI)*	*P* value
HbA1c ≤ 7%	0.95 (0.91–1.00)	0.041	1.01 (0.99–1.03)	0.23
PA ≤ 140/90 mmHg	0.879 (0.84–0.92)	<0.001	1.082 (1.06–1.13)	<0.001
LDL-cholesterol ≤130 mg/dL (CVD) ≤100 mg/dL (no CVD)	0.67 (0.64–0.70)	<0.001	0.74 (0.72–0.76)	<0.001
BMI ≤ 30 Kg/m^2	0.50 (0.48–0.52)	<0.001	0.53 (0.52–0.54)	<0.001
Nonsmoker	4.20 (3.86–4.58)	<0.001	4.01 (3.39–4.13)	<0.001

BMI: body mass index; BP: blood pressure; CVD: cardiovascular disease; OR: odds ratio.
*OR[a]: odds ratio adjusted by age, diabetes duration, treatment received, and sex (women).

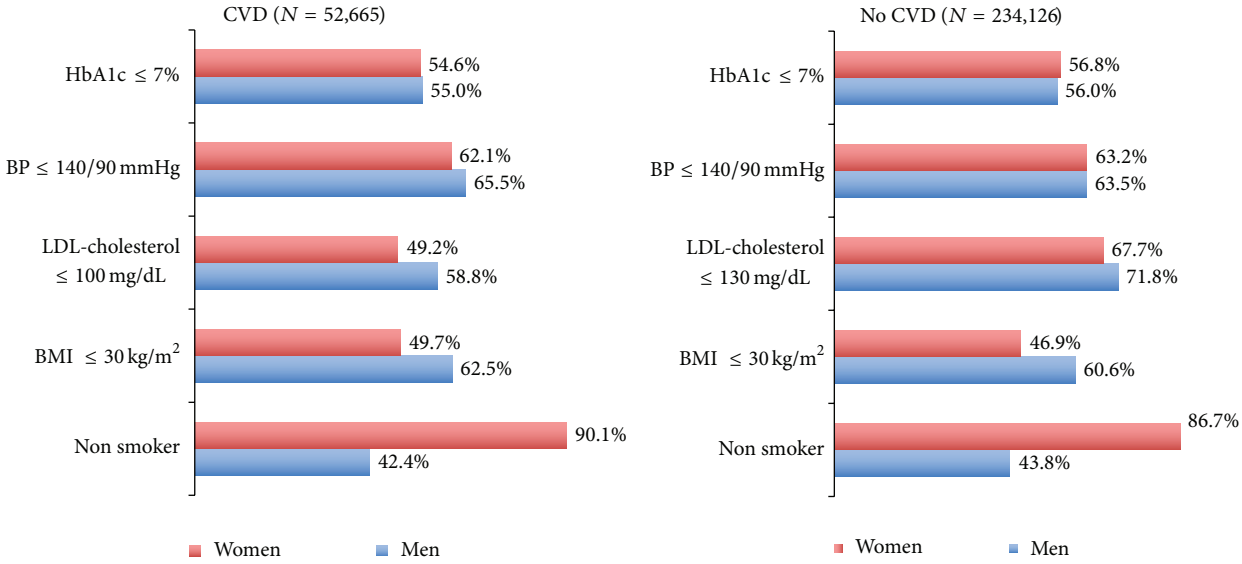


Figure 1: Percentage of patients with T2DM and good control of CVRF by gender and history of CVD (all variables showed significant differences between sexes ($P < 0.005$) and between CVD and no CVD in both men and women ($P < 0.001$), except for HbA1c: $P = 0.058$ in men and $P = 0.003$ in women. BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease).

The results of the study showed that there were significant gender differences in the control of T2DM and CVD individual risk factors. Namely, compared with men, women were on average older and had a longer duration of disease, and apart from less frequently being smokers than men, they had poorer control of hypertension, LDL-cholesterol levels, and BMI. This profile of worse control of CVRFs has been consistently reported before in previous surveys conducted in Spain and in other countries [30–32, 39, 43, 49–52], but the present study is the largest one ever performed in real-life clinical practice. Moreover, the proportion of women who achieved the target of stipulated recommendations to control the risk of CVD in our study was lower than men except for glycemic control, and the composite control of multiple risk outcomes (Hb1Ac, BP, and LDL-cholesterol simultaneously) was also poorer among women. These results are also in agreement with the above mentioned studies and with results from studies specifically assessing gender differences in composite risk factors in T2DM [43, 53], which have found that women are approximately 3 times less likely to achieve combined cardiometabolic control than men [43].

There are few reports assessing the control of CVRFs in T2DM according to gender as well as for the presence of prior CVD, and the present study is the first one conducted in a Spanish population. Our analysis stratifying by presence of prior CVD showed that both men and women with CVD in general had poorer control of CVRFs than those without. As for the degree of control of modifiable CVRFs, multivariate analysis showed that women with prior CVD were less likely to achieve their therapeutic targets than men for all parameters except for smoking. Women without CVD achieved the recommended HbA1c target as optimally as men and were better at controlling BP and smoking but again more frequently did not achieve recommended therapeutic targets for obesity and LDL-cholesterol. Our results on patients with prior CVD are in agreement with a previous cross-sectional study conducted in Germany, which found that women were more likely to have uncontrolled systolic BP,

Table 3: Degree of CVRFs control (% and 95% CI) in different macrovascular complications according to sex.

	CHD $N = 32{,}313$		Stroke $N = 18{,}768$		PAD $N = 8{,}420$		CHD + stroke $N = 3{,}670$		CHD + PAD $N = 2{,}312$		Stroke + PAD $N = 1{,}265$		CHD + stroke + PAD $N = 411$	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
HbA1c ≤ 7%	54.2 (53.4–54.9)	52.8 (51.7–53.9)	58.1 (57–59.1)	57.2 (56.0–58.5)	50.5 (49.1–51.9)	48.3 (45.8–50.8)	53.8 (51.5–56.0)	52.0 (48.8–55.2)	49.4 (46.8–52.0)	44.5 (39.0–50.1)	51.9 (48.5–55.4)	43.5 (36.5–50.6)	51.3 (45.3–57.4)	46.8 (32.0–61.6)
BP ≤ 140/90 mmHg	67.3 (66.0–66.7)	62.6 (61.7–63.6)	64.2 (63.3–65.2)	63.0 (61.9–64.2)	61.0 (59.8–62.3)	55.8 (53.5–58.1)	65.8 (63.8–67.8)	64.5 (61.1–67.4)	65.0 (62.8–67.3)	59.0 (53.9–64.0)	63.2 (60.0–66.3)	56.0 (49.5–62.5)	65.0 (59.7–70.4)	55.7 (42.9–68.6)
Nonsmoker	43.8 (43.1–44.4)	90.5 (89.9–91.0)	45.2 (44.2–46.2)	90.8 (90.1–91.4)	30.7 (29.6–31.9)	85.7 (84.1–87.3)	45.1 (43.1–47.2)	91.8 (90.2–93.4)	34.3 (32.1–36.5)	89.3 (86.2–92.5)	33.1 (30.1–36.1)	87.6 (83.3–91.8)	37.5 (32.2–42.9)	88.5 (80.3–96.8)
BMI ≤ 30 kg/m^2	39.7 (38.9–40.5)	52.4 (51.2–53.5)	34.3 (33.3–35.4)	47.8 (46.4–49.2)	33.0 (31.7–34.4)	47.7 (45.0–50.3)	34.0 (31.8–36.2)	50.8 (47.2–54.3)	35.9 (33.4–38.4)	47.3 (41.3–53.2)	31.9 (28.6–35.3)	44.0 (36.2–51.8)	31.1 (25.4–36.8)	53.5 (38.0–69.0)
LDL ≤ 130 mg/dL	89.1 (88.6–89.5)	82.8 (82.0–83.7)	84.9 (84.1–85.7)	78.9 (77.8–79.9)	82.2 (81.1–83.2)	73.7 (71.4–75.9)	90.9 (89.6–92.9)	84.4 (82.0–86.8)	89.8 (88.2–91.4)	81.5 (76.9–86.0)	86.1 (83.6–88.5)	79.0 (73.0–85.0)	88.0 (84.0–92.1)	81.0 (68.6–93.3)
LDL ≤ 100 mg/dL	63.1 (62.3–63.8)	53.2 (52.0–54.3)	56.4 (55.3–57.5)	46.8 (45.5–48.1)	51.8 (50.4–53.2)	42.2 (39.6–44.7)	65.1 (62.9–67.3)	54.7 (51.4–57.9)	62.4 (59.8–65.0)	58.4 (52.6–64.1)	58.4 (54.9–62.0)	48.6 (41.3–56.0)	59.8 (53.7–65.9)	54.8 (39.1–70.5)

BMI: body mass index; BP: blood pressure; CHD: coronary heart disease; PAD: peripheral artery disease.

Table 4: Treatment (%) used to control the different CVRFs in patients with or without CVD by gender.

Treatment	All patients $N = 286,791$			CVD $N = 52,665$			No CVD $N = 234,126$		
	Men $N = 153,987$	Women $N = 132,804$	P value	Men $N = 34,283$	Women $N = 18,382$	P value	Men $N = 119,704$	Women $N = 114,422$	P value
Glucose-lowering									
Lifestyle changes only	24.6	24.1	0.003	17.8	18.2	0.021	26.6	25.1	<0.001
Oral monotherapy	36.3	34.5	<0.001	33.8	29.2	<0.001	37.0	35.4	<0.001
Combination of OAD	22.9	21.9	<0.001	23.5	19.9	<0.001	22.7	22.2	0.001
Insulin + OAD	8.80	11.7	<0.001	13.3	18.1	<0.001	7.50	10.7	<0.001
Insulin monotherapy	7.37	7.80	<0.001	11.7	14.7	<0.001	6.10	6.70	<0.001
Any pharmacological treatment	*75.4*	*75.9*	*0.003*	*82.3*	*81.9*	*0.021*	*73.3*	*75*	*<0.001*
Antihypertensive									
No treatment	34.2	26.8	<0.001	13.6	11.6	<0.001	40.1	29.2	<0.001
ACE inhibitor/ARA2	16.3	14.9	<0.001	12.3	11.4	0.004	17.5	15.5	<0.001
Diuretic	2.01	4.4	<0.001	1.37	2.45	<0.001	2.20	4.72	<0.001
Beta-blocker	2.59	1.91	<0.001	5.60	3.37	<0.001	1.73	1.68	0.04
Calcium-channel blocker	2.19	2.15	0.43	3.82	3.28	0.001	1.73	1.97	<0.001
Combination of 2	22.7	26.8	<0.001	30.4	29.8	0.17	20.5	26.3	<0.001
Combination of 3 or more	19.5	22.8	<0.001	32.6	37.9	<0.001	15.7	20.3	<0.001
Any pharmacological treatment	*65.8*	*73.2*	*<0.001*	*86.4*	*88.4*	*<0.001*	*59.9*	*70.8*	*<0.001*
Lipid-lowering									
No treatment	50.3	49.4	<0.001	27.1	31.1	<0.001	56.9	52.4	<0.001
Statin	40.5	43.3	<0.001	60.2	58.9	0.003	34.8	40.8	<0.001
Fibrate	3.88	2.81	<0.001	2.36	2.17	0.17	4.31	2.91	<0.001
Statin + fibrate	1.06	0.67	<0.001	1.81	1.13	<0.001	0.84	0.59	<0.001
Any pharmacological treatment	*49.7*	*50.6*	*<0.001*	*72.9*	*68.9*	*<0.001*	*43.1*	*47.6*	*<0.001*
Antiplatelet									
No treatment	60.7	66.3	<0.001	22.5	28.2	<0.001	71.7	72.4	<0.001
Aspirin	31.4	28.8	<0.001	52.2	51.2	0.02	25.4	25.2	0.19
Clopidogrel	4.14	2.98	<0.001	12.6	11.9	0.01	1.71	1.55	0.004
Any pharmacological treatment	*39.3*	*33.7*	*<0.001*	*77.5*	*71.8*	*<0.001*	*28.3*	*27.6*	*<0.001*

ACE: acetylcholinesterase; ARA2: angiotensin II receptor antagonist; BMI: body mass index; BP: blood pressure; CVD: cardiovascular disease; OAD: oral antidiabetic drugs.

LDL-cholesterol, and HbA1c levels [25]; similarly, another cross-sectional analysis conducted in the US found that women were more liable to have suboptimal control of systolic BP and LDL-cholesterol but found no differences in glycemic control relative to men [45]. As for patients without prior CVD, the US study found no significant differences in the degree of control of any studied modifiable CVRF [45], and the German study only found a higher probability of women having uncontrolled LDL-cholesterol relative to men [25], which is in agreement with our results, although we also found that women had even better control of BP than men. Unfortunately, our results on smoking and BMI cannot be compared with these 2 studies, since both of them included these 2 risk factors as confounding covariates in their analysis.

There is compelling evidence in Spain and other countries that women receive less health care attention not only for the treatment of their T2DM [54], but also for the prevention and treatment of associated CV complications [14, 19, 25, 26, 30, 44, 45], as women both with and without CVD receive less lipid-lowering and antithrombotic therapy than men [29, 47, 55, 56]. Studies stratifying by gender and comorbid CVD are scarce but concur that women are less intensively treated with lipid-lowering drugs than men, in patients both with and without prior CVD, while findings on gender disparities according to prior CVD regarding the use or intensity of treatment with antihypertensive or glucose-lowering drugs are inconsistent across reports [25, 45, 47]. Differences between studies may be due to genetic or ethnic differences, geographical variations in access to available health care resources, different ambulatory physician practices between countries, and disparities in the economic barriers to care due to the type of insurance (public or private) paying for the treatment.

When we assessed whether there were gender disparities in the management of modifiable CVRF in T2DM patients according to a history of CVD, we found that women were more likely to be treated with antihypertensive drugs and less likely to take antiplatelet drugs than men irrespective of having a history of CVD, while glucose- and lipid-lowering treatment varied according to the absence/presence of prior CVD: the proportion of women with CVD taking glucose and/or lipid-lowering medications was similar to men, but women without CVD took more glucose and/or lipid-lowering drugs than men. However, while the degree of achieved glycemic control was similar between women with and without previous CVD, lipid levels were remarkably uncontrolled in both cases and more pronounced in women with prior CVD. This is of concern if we take into account that a history of CVD is an independent factor associated with higher morbidity and mortality and that the 4-year survival rate of women with prior CVD is lower than in women without a history of CVD [30]. Moreover, the fact that women without prior CVD did not achieve adequate control of lipid levels, in spite of being more likely to be treated with lipid-lowering medications than men, could be related to the use of less intensive therapy or to a differential response to statins relative to men, although this is controversial in the case of primary prevention [57, 58]. With regard to the degree of control of BP, we observed that women without CVD had similar control to men, in spite of higher levels of treatment with antihypertensive drugs, while women with CVD still had uncontrolled BP relative to men although they were treated in a comparable proportion, an observation that has been previously reported [29]. This is also of concern if we consider that women have a higher lifetime risk of stroke than men, in part because they have a longer life expectancy and because the risk of stroke increases with age [59], therefore, underlining the need for more intensive or proper control of BP. Taken together, our results show that the treatment and control of the 2 parameters that most effectively prevent CVD, namely, BP and lipid levels, remain a challenge (particularly LDL-cholesterol levels) in the case of women with T2DM and a history of CVD.

Strengths of the present study include the use of registries coming from primary care medical records, which allows the collection of a large volume of patients' real-life clinical practice data. However, there are some limitations that should be acknowledged and considered when interpreting the results of this study. Firstly, inherent to any cross-sectional design, no causal associations or conclusion on trends in treatment can be drawn, and the retrospective design is subject to biases concerning the lack of data recording for some of the studied variables (e.g., 25% of patients did not have corresponding HbA1c values for the previous year). Secondly, the studied cohort is representative of a specific territory in Spain and may not necessarily reflect standards of care in other territories. Thirdly, information on treated (and the specific therapeutic agents prescribed) and untreated patients was based on drugs obtained at the pharmacy, and we were not able to assess medication adherence factors. Finally, we had no data to assess factors known to differ by gender in T2DM that may influence disease outcomes, such as diabetes knowledge, self-management practices, lifestyle related factors, socioeconomic status, education, or social support [51].

5. Conclusions

The results of the study confirm that Spanish women with T2DM have suboptimal control of CVRFs; they also show that compared with men women with CVD were less likely to achieve therapeutic goals for BMI, BP, LDH-cholesterol, and HbA1c and that those without a history of CVD were also less likely to achieve BMI and LDL-cholesterol recommended goals. Furthermore, although the proportion of women treated with lipid-lowering medications was similar to or even higher than men, LDL-cholesterol levels were remarkably uncontrolled in both women with and without CVD, and women with CVD still had uncontrolled BP relative to men in spite of being treated with antihypertensive drugs in a comparable proportion of cases. The observed differences have clinical implications that warrant further investigation through studies specifically designed to assess gender differences in the control of modifiable CVRF and further stress the need to implement measures to better prevent and treat this subgroup of diabetic women. Actions should include not only targeted awareness programs for health professionals, but also the implementation of specific

educational programs aimed at improving self-awareness and self-care in women with T2DM.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

The Catalan Diabetes Association, the Catalan Health Department, and part of an unrestricted grant provided by Sanofi-aventis Spain supported this study, as well as the Network of Preventive Activities and Health Promotion in Primary Care (redIAPP) granted by the Instituto de Salud Carlos III (RD06/0018). The authors also acknowledge Mònica Gratacòs and Maren White for providing support in the paper preparation and editing.

References

[1] J. E. Shaw, R. A. Sicree, and P. Z. Zimmet, "Global estimates of the prevalence of diabetes for 2010 and 2030," *Diabetes Research and Clinical Practice*, vol. 87, no. 1, pp. 4–14, 2010.

[2] D. R. Whiting, L. Guariguata, C. Weil, and J. Shaw, "IDF Diabetes Atlas: global estimates of the prevalence of diabetes for 2011 and 2030," *Diabetes Research and Clinical Practice*, vol. 94, no. 3, pp. 311–321, 2011.

[3] L. Guariguata, D. R. Whiting, I. Hambleton et al., "Global estimates of diabetes prevalence for 2013 and projections for 2035," *Diabetes Research and Clinical Practice*, vol. 103, no. 2, pp. 137–149, 2014.

[4] International Diabetes Federation, *IDF Diabetes Atlas*, International Diabetes Federation, Brussels, Belgium, 6th edition, 2013.

[5] F. Soriguer, A. Goday, A. Bosch-Comas et al., "Prevalence of diabetes mellitus and impaired glucose regulation in Spain: the Di@bet.es Study," *Diabetologia*, vol. 55, no. 1, pp. 88–93, 2012.

[6] R. P. Donahue and T. J. Orchard, "Diabetes mellitus and macrovascular complications: an epidemiological perspective," *Diabetes Care*, vol. 15, no. 9, pp. 1141–1155, 1992.

[7] G. L. Booth, M. K. Kapral, K. Fung, and J. V. Tu, "Relation between age and cardiovascular disease in men and women with diabetes compared with non-diabetic people: a population-based retrospective cohort study," *The Lancet*, vol. 368, no. 9529, pp. 29–36, 2006.

[8] J. Leal, A. M. Gray, and P. M. Clarke, "Development of life-expectancy tables for people with type 2 diabetes," *European Heart Journal*, vol. 30, no. 7, pp. 834–839, 2009.

[9] P. Gæde, P. Vedel, N. Larsen, G. V. H. Jensen, H.-H. Parving, and O. Pedersen, "Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes," *The New England Journal of Medicine*, vol. 348, no. 5, pp. 383–393, 2003.

[10] R. R. Holman, S. K. Paul, M. A. Bethel, D. R. Matthews, and H. A. W. Neil, "10-Year follow-up of intensive glucose control in type 2 diabetes," *The New England Journal of Medicine*, vol. 359, no. 15, pp. 1577–1589, 2008.

[11] E. Mannucci, I. Dicembrini, A. Lauria, and P. Pozzilli, "Is glucose control important for prevention of cardiovascular disease in diabetes?" *Diabetes Care*, vol. 36, supplement 2, pp. S259–S263, 2013.

[12] American Diabetes Association, "Standards of medical care in diabetes—2014," *Diabetes Care*, vol. 37, supplement 1, pp. S14–S80, 2014.

[13] C. B. Giorda, A. Avogaro, M. Maggini et al., "Recurrence of cardiovascular events in patients with type 2 diabetes: epidemiology and risk factors," *Diabetes Care*, vol. 31, no. 11, pp. 2154–2159, 2008.

[14] C. H. Jørgensen, G. H. Gislason, O. Ahlehoff, C. Andersson, C. Torp-Pedersen, and P. R. Hansen, "Use of secondary prevention pharmacotherapy after first myocardial infarction in patients with diabetes mellitus," *BMC Cardiovascular Disorders*, vol. 14, article 4, 2014.

[15] T. J. Orchard, "The impact of gender and general risk factors on the occurrence of atherosclerotic vascular disease in non-insulin-dependent diabetes mellitus," *Annals of Medicine*, vol. 28, no. 4, pp. 323–333, 1996.

[16] A. M. Kanaya, D. Grady, and E. Barrett-Connor, "Explaining the sex difference in coronary heart disease mortality among patients with type 2 diabetes mellitus: a meta-analysis," *Archives of Internal Medicine*, vol. 162, no. 15, pp. 1737–1745, 2002.

[17] W. L. Lee, A. M. Cheung, D. Cape, and B. Zinman, "Impact of diabetes on coronary artery disease in women and men: a meta-analysis of prospective studies," *Diabetes Care*, vol. 23, no. 7, pp. 962–968, 2000.

[18] F. B. Hu, M. J. Stampfer, C. G. Solomon et al., "The impact of diabetes mellitus on mortality from all causes and coronary heart disease in women: 20 years of follow-up," *Archives of Internal Medicine*, vol. 161, no. 14, pp. 1717–1723, 2001.

[19] R. Huxley, F. Barzi, and M. Woodward, "Excess risk of fatal coronary heart disease associated with diabetes in men and women: meta-analysis of 37 prospective cohort studies," *British Medical Journal*, vol. 332, no. 7533, pp. 73–78, 2006.

[20] W. P. Castelli, "Cardiovascular disease in women," *American Journal of Obstetrics and Gynecology*, vol. 158, no. 6, part 2, pp. 1553–1560, 1988.

[21] A. P. V. Dantas, Z. B. Fortes, and M. H. C. de Carvalho, "Vascular disease in diabetic women: why do they miss the female protection?" *Experimental Diabetes Research*, vol. 2012, Article ID 570598, 10 pages, 2012.

[22] E. L. Barrett-Connor, B. A. Cohn, D. L. Wingard, and S. L. Edelstein, "Why is diabetes mellitus a stronger risk factor for fatal ischemic heart disease in women than in men? The Rancho Bernardo Study," *Journal of the American Medical Association*, vol. 265, no. 5, pp. 627–631, 1991.

[23] A. Juutilainen, S. Kortelainen, S. Lehto, T. Rönnemaa, K. Pyörälä, and M. Laakso, "Gender difference in the impact of type 2 diabetes on coronary heart disease risk," *Diabetes Care*, vol. 27, no. 12, pp. 2898–2904, 2004.

[24] J. Marrugat, J. Sala, and J. Aboal, "Epidemiology of cardiovascular disease in women," *Revista Espanola de Cardiologia*, vol. 59, no. 3, pp. 264–274, 2006.

[25] I. Gouni-Berthold, H. K. Berthold, C. S. Mantzoros, M. Böhm, and W. Krone, "Sex disparities in the treatment and control of cardiovascular risk factors in type 2 diabetes," *Diabetes Care*, vol. 31, no. 7, pp. 1389–1391, 2008.

[26] P. C. Gutiérrez, J. M. L. Bejarano, J. R. G. Juanatey, A. G. Núñez, F. J. P. Fernández, and A. N. Sardá, "Different approach in high-cardiovascular-risk women, compared to men: a multidisciplinary study-Spain," *Medicina Clinica*, vol. 120, no. 12, pp. 451–455, 2003.

[27] S. D. Persell and D. W. Baker, "Aspirin use among adults with diabetes: recent trends and emerging sex disparities," *Archives of Internal Medicine*, vol. 164, no. 22, pp. 2492–2499, 2004.

[28] S. Tonstad, E. O. Rosvold, K. Furu, and S. Skurtveit, "Under-treatment and overtreatment with statins: the Oslo Health Study 2000-2001," *Journal of Internal Medicine*, vol. 255, no. 4, pp. 494–502, 2004.

[29] D. J. Wexler, R. W. Grant, J. B. Meigs, D. M. Nathan, and E. Cagliero, "Sex disparities in treatment of cardiac risk factors in patients with type 2 diabetes," *Diabetes Care*, vol. 28, no. 3, pp. 514–520, 2005.

[30] R. Vidal-Pérez, F. Otero-Raviña, L. Grigorian-Shamagian et al., "Sex does not influence prognosis in diabetic patients. The Barbanza Diabetes study," *Revista Espanola de Cardiologia*, vol. 63, no. 2, pp. 170–180, 2010.

[31] L. Franzini, D. Ardigò, F. Cavalot et al., "Women show worse control of type 2 diabetes and cardiovascular disease risk factors than men: results from the MIND.IT Study Group of the Italian Society of Diabetology," *Nutrition, Metabolism and Cardiovascular Diseases*, vol. 23, no. 3, pp. 235–241, 2013.

[32] G. Penno, A. Solini, E. Bonora et al., "Gender differences in cardiovascular disease risk factors, treatments and complications in patients with type 2 diabetes: the RIACE Italian multicentre study," *Journal of Internal Medicine*, vol. 274, no. 2, pp. 176–191, 2013.

[33] E. W. Gregg, Q. Gu, Y. J. Cheng, K. M. V. Narayan, and C. C. Cowie, "Mortality trends in men and women with diabetes, 1971 to 2000," *Annals of Internal Medicine*, vol. 147, no. 3, pp. 149–155, 2007.

[34] A. D. Morris, D. I. R. Boyle, R. MacAlpine et al., "The diabetes audit and research in Tayside Scotland (DARTS) study: electronic record linkage to create a diabetes register," *British Medical Journal*, vol. 315, no. 7107, pp. 524–528, 1997.

[35] B. Eliasson, J. Cederholm, P. Nilsson, and S. Gudbjörnsdóttir, "The gap between guidelines and reality: type 2 diabetes in a national diabetes register 1996–2003," *Diabetic Medicine*, vol. 22, no. 10, pp. 1420–1426, 2005.

[36] I. Vinagre, M. Mata-Cases, E. Hermosilla et al., "Control of glycemia and cardiovascular risk factors in patients with type 2 diabetes in primary care in Catalonia (Spain)," *Diabetes Care*, vol. 35, no. 4, pp. 774–779, 2012.

[37] J. A. M. Sperl-Hillen and P. J. O'Connor, "Factors driving diabetes care improvement in a large medical group: ten years of progress," *American Journal of Managed Care*, vol. 11, supplement 5, pp. S177–S185, 2005.

[38] B. Bolíbar, F. Fina Avilés, R. Morros et al., "SIDIAP database: electronic clinical records in primary care as a source of information for epidemiologic research," *Medicina Clinica*, vol. 138, no. 14, pp. 617–621, 2012.

[39] M. Mata-Cases, P. Roura-Olmeda, M. Berengué-Iglesias et al., "Fifteen years of continuous improvement of quality care of type 2 diabetes mellitus in primary care in Catalonia, Spain," *International Journal of Clinical Practice*, vol. 66, no. 3, pp. 289–298, 2012.

[40] M. Mata-Cases, F. X. Cos-Claramunt, R. Morros et al., *Abordatge de la Diabetis Mellitus Tipus 2*, Guies de Pràctica Clínica, num 15, Institut Català de la Salut, Barcelona, Spain, 2010.

[41] Ministerio de Sanidad y Consumo, "Guía de práctica clínica sobre diabetes tipo 2," 2008, http://www.guiasalud.es/viewGPC.asp?idGuia=429.

[42] E. Raum, H. U. Krämer, G. Rüter et al., "Medication non-adherence and poor glycaemic control in patients with type 2 diabetes mellitus," *Diabetes Research and Clinical Practice*, vol. 97, no. 3, pp. 377–384, 2012.

[43] J. L. Strom Williams, C. P. Lynch, R. Winchester et al., "Gender differences in composite control of cardiovascular risk factors among patients with type 2 diabetes," *Diabetes Technology and Therapeutics*, vol. 16, no. 7, pp. 421–427, 2014.

[44] H. U. Krämer, E. Raum, G. Rüter et al., "Gender disparities in diabetes and coronary heart disease medication among patients with type 2 diabetes: results from the DIANA study," *Cardiovascular Diabetology*, vol. 11, article 88, 2012.

[45] A. Ferrara, C. M. Mangione, C. Kim et al., "Sex disparities in control and treatment of modifiable cardiovascular disease risk factors among patients with diabetes: Translating Research Into Action for Diabetes (TRIAD) study," *Diabetes Care*, vol. 31, no. 1, pp. 69–74, 2008.

[46] A. Becker, G. Bos, F. de Vegt et al., "Cardiovascular events in type 2 diabetes: comparison with nondiabetic individuals without and with prior cardiovascular disease: 10-Year follow-up of the Hoorn study," *European Heart Journal*, vol. 24, no. 15, pp. 1406–1413, 2003.

[47] M. Baviera, P. Santalucia, L. Cortesi et al., "Sex differences in cardiovascular outcomes, pharmacological treatments and indicators of care in patients with newly diagnosed diabetes: analyses on administrative database," *European Journal of Internal Medicine*, vol. 25, no. 3, pp. 270–275, 2014.

[48] F. Mo, L. M. Pogany, F. C. K. Li, and H. Morrison, "Prevalence of diabetes and cardiovascular comorbidity in the Canadian Community Health Survey 2002–2003," *TheScientificWorldJournal*, vol. 6, pp. 96–105, 2006.

[49] M. Comaschi, C. Coscelli, D. Cucinotta, P. Malini, E. Manzato, and A. Nicolucci, "Cardiovascular risk factors and metabolic control in type 2 diabetic subjects attending outpatient clinics in Italy: the SFIDA (survey of risk factors in Italian diabetic subjects by AMD) study," *Nutrition, Metabolism and Cardiovascular Diseases*, vol. 15, no. 3, pp. 204–211, 2005.

[50] G. J. Winston, R. G. Barr, O. Carrasquillo, A. G. Bertoni, and S. Shea, "Sex and racial/ethnic differences in cardiovascular disease risk factor treatment and control among individuals with diabetes in the Multi-Ethnic Study of Atherosclerosis (MESA)," *Diabetes Care*, vol. 32, no. 8, pp. 1467–1469, 2009.

[51] M. Sandín, A. Espelt, A. Escolar-Pujolar, L. Arriola, and I. Larrañaga, "Desigualdades de género y diabetes mellitus tipo 2: la importancia de la diferencia," *Avances en Diabetología*, vol. 27, no. 3, pp. 78–87, 2011.

[52] M. Sekerija, T. Poljicanin, K. Erjavec, A.-M. Liberati-Cizmek, M. Prašek, and Z. Metelko, "Gender differences in the control of cardiovascular risk factors in patients with type 2 diabetes -a cross-sectional study," *Internal Medicine*, vol. 51, no. 2, pp. 161–166, 2012.

[53] C. J. Homko, L. Zamora, W. P. Santamore, A. Kashem, T. McConnell, and A. A. Bove, "Gender differences in cardiovascular risk factors and risk perception among individuals with diabetes," *Diabetes Educator*, vol. 36, no. 3, pp. 483–488, 2010.

[54] R. Correa-de-Araujo, K. McDermott, and E. Moy, "Gender differences across racial and ethnic groups in the quality of care for diabetes," *Women's Health Issues*, vol. 16, no. 2, pp. 56–65, 2006.

[55] A. Ferrara, D. F. Williamson, A. J. Karter, T. J. Thompson, and C. Kim, "Sex differences in qualify of health care related to ischemic heart disease prevention in patients with diabetes: the Translating Research Into Action for Diabetes (TRIAD) study, 2000-2001," *Diabetes Care*, vol. 27, no. 12, pp. 2974–2976, 2004.

[56] D. P. Nau and U. Mallya, "Sex disparity in the management of dyslipidemia among patients with type 2 diabetes mellitus in a managed care organization," *The American Journal of Managed Care*, vol. 11, no. 2, pp. 69–73, 2005.

[57] J. M. Walsh and M. Pignone, "Drug Treatment of Hyperlipidemia in Women," *Journal of the American Medical Association*, vol. 291, no. 18, pp. 2243–2252, 2004.

[58] S. Mora, R. J. Glynn, J. Hsia, J. G. MacFadyen, J. Genest, and P. M. Ridker, "Statins for the primary prevention of cardiovascular events in women with elevated high-sensitivity C-reactive protein or dyslipidemia: results from the justification for the use of statins in prevention: an intervention trial evaluating rosuvastatin (JUPITER) and meta-analysis of women from primary prevention trials," *Circulation*, vol. 121, no. 9, pp. 1069–1077, 2010.

[59] S. Seshadri, A. Beiser, M. Kelly-Hayes et al., "The lifetime risk of stroke: estimates from the framingham study," *Stroke*, vol. 37, no. 2, pp. 345–350, 2006.

4.4 Cuarto Artículo

Control metabólico y de los factores de riesgo cardiovascular en pacientes con Diabetes tipo 2 según la duración de la diabetes. ***Family Practice, 2015.***

Family Practice, 2015, Vol. 32, No. 1, 27–34
doi:10.1093/fampra/cmu048
Advance Access publication 5 September 2014

Metabolic control and cardiovascular risk factors in type 2 diabetes mellitus patients according to diabetes duration

Josep Franch-Nadal[a,b,*], Pilar Roura-Olmeda[c], Belén Benito-Badorrey[a], Antonio Rodriguez-Poncelas[d,e], Gabriel Coll-de-Tuero[d,e,f], Manel Mata-Cases[b,g] on behalf of the GEDAPS (Primary care Group for the study of Diabetes)[+]

[a]Primary Care Center Raval Sud, Barcelona, Spain; [b]Barcelona Ciutat Research Support Unit – IDIAP Jordi Gol, Barcelona, Spain; [c]PCC Badía del Vallés, Barcelona, Spain; [d]PCC Anglés, Girona, Spain; [e]Research Unit, Healthcare Institute, Girona, Spain; [f]Translab. Departament of Medical Sciences, University of Girona, Girona, Spain and [g]PCC La Mina, Sant Adrià de Besòs, Barcelona, Spain.

*Correspondence to Josep Franch Nadal, Avd Drassanes 17–21, 08001 Barcelona, Spain; E-mail: josep.franch@gmail.com
[+]See Appendix.

Received February 2 2014; revised May 13 2014; Accepted August 4 2014.

Abstract

Background. Control of glycaemic levels as well as cardiovascular risk factors (CVRF) is essential to prevent the onset of complications associated with type 2 diabetes mellitus (T2DM).
Aim. To describe the degree of glycaemic control and CVRF in relation to diabetes duration.
Patients and methods. Multicentre cross-sectional study in T2DM patients seen in primary care centres during 2007. Variables: Demographical and clinical characteristics, antidiabetic treatments and development of disease complications. Diabetes duration classification: 0–5, 6–10, 11–20 and >20 years. Logistic regression models were used in the analysis.
Results. A total of 3130 patients; 51.5% males; mean age: 68 ± 11.7 years; mean diabetes duration:7.0 (±5.6) years, median: 5 (interquartile range:3–9) years; mean HbA_{1c}: 6.84 (±1.5), were analyzed. There has been a progressive decline in HbA_{1c} levels (HbA_{1c} > 7% in 25.8% of patients during the first 5 years and 51.8% after 20 years). Blood pressure values remained relatively stable throughout disease duration. The mean value of low density lipoprotein (LDL) experienced a slight decline with the progression of the disease, but due to the significant increase of cardiovascular disease (CVD) after 20 years of duration, less patients reached the recommended target (LDL < 100 mg/dl) in secondary prevention. Logistic regression model controlling for age, sex and CVD showed that diabetes duration was related to glycaemic control (odds ratio: 1.066, 95% confidence interval: 1.050–1.082 per year) but not to blood pressure or LDL control.
Conclusions. The degree of glycaemic control and the risk factors in relation to the duration of T2DM followed different patterns. Diabetes duration was associated with a poorer glycaemic control but in general had a limited role in blood pressure control or lipid profile.

Key words: Cardiovascular risk factors, control, disease duration, T2DM.

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic disease that affects 13.8% of the Spanish adult population, with up to 6% of the patients remaining undiagnosed (1). T2DM care is a complex process that involves not only the control of glycaemic levels but also a tight management of other abnormalities such as dyslipidemia, hypertension, hypercoagulability, obesity and insulin

resistance, among others (2). To prevent or diminish the progression of microvascular and macrovascular complications, recommended diabetes management necessarily encompasses both glycaemic control and control of cardiovascular risk factors (CVRF) (3). The STENO-2 study has shown that global control of all risk factors is more effective compared to single intensification, achieving a 57% reduction in cardiovascular mortality and a 59% reduction of the composite criterion [cardiovascular mortality, ischaemic heart disease (IHD), stroke, revascularization and amputation (4)].

Diabetes duration is one of the most important indicators of the presence of diabetic complications (5–8). For that reason it has been included among the tools to estimate cardiovascular risk and diabetic populations such as the UKPDS risk engine (9) or ADVANCE (10). It is closely linked to the rate of progression of atherosclerosis and some studies have shown that after 7–10 years from the diagnosis of DM cardiovascular risk considerably increases and may even similar to the risk of patients who have had a myocardial infarction (11–13).

Recent trials suggest that intensive glucose control among people with long-standing T2DM has limited cardiovascular benefits, whereas an early treatment at the beginning of the disease, as in the UKPDS study, may be associated with significant micro and macrovascular benefits through the so called 'legacy effect (14)'.

Despite scientific evidence and the publication of international and national guidelines (3), adequate control of these patients' health remains suboptimal. Although some studies have assessed metabolic control at the time of diagnosis (15,16), surprisingly there is only limited data analyzing its evolution in relation to diabetes duration (17–19).

The aim of this study was to describe the degree of glycaemic control and CVRFs in relation to diabetes duration.

Research design and methods

Study design

Multicentre cross-sectional study conducted in a random sample of T2DM patients seen in 52 primary care centres in Catalonia in 2007 for a total population of 1 126 532 inhabitants, a 16% of the total population of Catalonia (7 M (18)). Health providers (primary care physicians or nurses) were instructed to obtain an electronically random sample from the medical records of T2DM patients. A total sample of five multiplied by the number of basic care units (physician/nurse), with a minimum of 30 patients per centre, was required. A selection of medical records with an additional 20% was performed. In those cases that did not fulfill the inclusion criteria the medical record was replaced by the next one of the same gender in the list. Exclusion criteria included: patients with a follow-up less than 6 months since diagnosis, type 1 DM, patients exclusively controlled by an endocrinologist and short life expectancy (terminal patients or those that received home care). A detailed description of the methodology of the GEDAPS (Spanish Primary Care Diabetes Study Group) evaluations has been published elsewhere (17,18). The study protocol was approved by the institutional review board and the study was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, based only on clinical records, patients were not required to give written informed consent. To assure anonymity data were collected and recorded using two different files: one included demographical variables and the other one clinical variables linked by a consecutive record number.

Clinical data

Clinical data were extracted from the electronic medical records by physicians participating in the GEDAPS Continuous Quality Improvement (GCQI) program in Catalonia (20,21). The GCQI program gathers periodically information from primary care centres on process and outcomes indicators since 1993. In 1993, the group published the first edition of the 'Guidelines for Diabetes Management in Primary Health Care in Spain' that included both clinical and organizational recommendations and also defined a set of quality care indicators. The guidelines were updated in the following years (1995, 1998, 2000, 2004 and 2011) and have been used widely by health professionals in primary care in Spain (20). Clinical data were entered by each researcher directly in the GEDAPS webpage for subsequent analysis (21).

Sociodemographical (age, gender), anthropometric (weight, height, body mass index (BMI) and clinical characteristics were analyzed. The last measurements of clinical and laboratory data were recorded, except for blood pressure that was the mean of the last three measurements during 2007. Among the clinical variables included: year of diagnosis (date when patient accomplished the diabetes diagnosis criteria), HbA_{1c}, renal function (creatinin, glomerular filtration, urinary albumin excretion); clinical characteristics of hypertension [blood pressure values: systolic blood pressure (SBP) and diastolic blood pressure (DBP); antihypertensive treatment]; complications associated and T2DM treatment (diet, oral hypoglycaemic agents or insulin); clinical characteristics of dyslipidaemia (lipid profile; lipid lowering treatment); antiplatelet therapy. Degree of glycaemic control and CVRF were evaluated according to the cut-off points defined by the recommendations of the GCQI program in Catalonia (20,21). Poor metabolic control was defined according to the values of the following variables: HbA_{1c} > 7%, BP > 140/90 mmHg, LDL>100 [patients with cardiovascular disease (CVD) – secondary prevention]/>130 (patients without CVD – primary prevention) mg/dl, BMI ≥ 30 kg/m^2 or current smoking habit. The variable time since diagnosis was classified in four

categories: 0–5, 6–10, 11–20, and >20 years. The diagnostic criteria for complications were as followed: (i) Retinopathy was defined as the presence of any lesion, whether proliferative or not, such as amaurosis (the loss of vision in one or both eyes) diagnosed by an ophthalmologist; (ii) Nephropathy was defined as microalbuminuria (>30 mg/24 hours or albumin creatinin ratio > 30 mg/dl), and chronic renal failure by a glomerular filtration (MDRD) <60 mg/minute; (iii) Any previously diagnosed vascular lesion and/or nontraumatic amputation, at any level of the lower limbs, were considered diabetic foot; (iv) cardiovascular events were defined as: IHD (acute myocardial infarction, angina pectoris or Q waves or ST ischaemic changes in the annual EKG), stroke or transient ischaemic attack reported in the hospital discharge forms.

Statistical analysis

Continuous variables were described using the mean and standard deviation. Categorical variables were described as percentage with the confidence interval of 95% (95% CI). The chi-square test was used to evaluate the association between categorical variables. For continuous variables, the t-student test, the non-parametric Mann–Whitney U test, and one-way analysis of variance were performed. Logistic regression models were created to determine the association between diabetes duration and other variables. A two-tailed value of $P < 0.05$ was considered statistically significant.

Results

Patients' clinical characteristics

A total of 3310 patients (51.4% men and 48.6% women), with a mean age of 68.0 (±11.7) years, 46% over 70 years of age, were included in the study. The mean HbA_{1c} was 6.84% ± 1.46 and the mean diabetes duration was 7.0 (± 5.6) years, median: 5 years (interquartile range: 3–9) years. Table 1 summarizes the main clinical characteristics of the patients globally and according to gender as well as the absence (primary prevention) or presence (secondary prevention) of some manifestation of CVD. Women were significantly older, with more advanced diabetes (7.4 versus 6.6 years) and more obese than men. About 181 patients had no recorded data about CVD. CVDs were reported in 513 (17.4%) of the remaining patients. Patients with CVD were older and the duration of the disease was significantly longer.

Table 1. Population characteristics according to gender, age and cardiovascular prevention

	Total	Men	Women	Primary prevention (without CVD)	Secondary prevention (with CVD)
N	3130	1611	1519	2436	513
Age	68.0 ± 11,7	66.8 ± 11.6	69.3 ± 11.6	67.3 ± 11.8	72.2 ± 10.3‡
Diabetes duration	7.0 ± 5.6	6.6 ± 5.1	7.4 ± 6.0	6.85 ± 5.52	7.90 ± 5.75‡
BMI (kg/m²)	30.2 ± 5.08	29.2 ± 4.3	31.3 ± 5.6	30.3 ± 5.15	29.8 ± 4.9
BMI distribution (%)					
BMI<25	404 (15.7%)	235 (17.6%)	169 (13.6%)	314 (15.6%)	75 (17.4%)
BMI 25–30	1082 (42.0%)	638 (47.9%)	444 (35.7%)	856 (42.4%)	173 (40.2%)
BMI>30	1088 (42.3%)	459 (34.5%)	629 (50.6%)	847 (42.0%)	182 (42.3%)
Current smoker (%)	405 (12.9%)	331 (20.5)‡	74 (4.9%)	334 (14.5%)	41 (8.6%)‡
Creatinin (mg/dl)	1.20 ± 1.03	1.30 ± 1.12‡	1.10 ± 0.92	1.21 ± 1.03	1.26 ± 1.14
Glomerular filtration (MDRD) (ml/minute)	76.3 ± 32.8	79.6 ± 29.5	72.7 ± 35.7	81.1 ± 44.9	71.3 ± 32.9‡
Albuminuria (mg/dl)	32.6 ± 95.9	40.2 ± 118†	24.8 ± 64.6	29.8 ± 89.7	47.4 ± 120*
Microalbuminuria (%)	241 (12.4%)	133 (13.3%)	108 (11.4%)	174 (14.4%)	50 (23.3%)‡
Macroalbuminuria (%)	89 (4.6%)	60 (6.0%)	29 (3.1%)	20 (1.7%)	8 (3.7%)*
HbA_{1c} (%)	6.84 ± 1.46	6.83 ± 1.47	6.85 ± 1.44	6.82 ± 1.46	6.89 ± 1.44
SBP (mmHg)	137.0 ± 14.7	137.0 ± 14.7	137.1 ± 14.7	137.1 ± 14.6	137.0 ± 14.9
DBP (mmHg)	76.5 ± 9.0	76.5 ± 9.1	76.4 ± 8.9	76.8 ± 8.84‡	73.9 ± 9.23
Total cholesterol (mg/dl)	194 ± 38.4	188 ± 38.4	201 ± 37.2‡	197 ± 38.0‡	180 ± 37.6
HDL cholesterol (mg/dl)	50.2 ± 13.3	47.6 ± 12.8	53.0 ± 13.3‡	50.7 ± 13.5	47.9 ± 11.8‡
LDL cholesterol (mg/dl)	115 ± 32.9	111 ± 32.5	119 ± 32.9‡	117 ± 32.5‡	104 ± 31.9
Non-HDL cholesterol	144 ± 37.4	141 ± 37.7	148 ± 36.7‡	146 ± 37.1‡	133 ± 36.2
Triglycerides (mg/dl)	151 ± 119	154 ± 142	148 ± 89.4	152 ± 124	144 ± 100

Numeric variables are expressed as mean ± standard deviation. BMI, body mass index; CVD, cardiovascular disease; DBP, diastolic blood pressure; HDL, high density lipoprotein; LDL, low density lipoprotein; MDRD, modification of diet in renal disease; SBP, systolic blood pressure; TC, total cholesterol.
*$P < 0.05$; †$P < 0.01$; ‡$P < 0.001$.

The percentages of patients receiving any pharmacological antidiabetic treatment increases with diabetes duration (71.5% for 0–5 years, 83.2% for 6–10 years, 91.8% for 10–20 years and 96.4% for >20 years), whereas the increase is smaller for antihypertensive (63.4%, 68.7%, 72% and 68.7%, respectively) and lipid-lowering treatments (43.1%, 51%, 50.7% and 47%, respectively). Both in primary and secondary prevention, patients with poorly controlled disease (HbA_{1c} ≥ 7% or BP ≥ 140/90) used more combination treatments (antihyperglycaemic and antihypertensive drugs). Lipid lowering treatments were only reported in cases of secondary prevention. It is important to note that antiplatelets were taken by 86.7% of patients with IHD, 79.8% with stroke and 37.3% of those without CVD.

Metabolic control according to diabetes duration

Table 2 summarizes the sample description according to diabetes duration. Patients with a longer time of disease duration were: significantly older; with a predominance of women; with a lower BMI as well as lower percentage of current smokers, higher levels of HbA_{1c} and lower glomerular filtration; higher SBP and lower DBP and finally, with regards to blood lipids, lower levels of total cholesterol, LDL and nonhigh density lipoprotein (HDL) cholesterol and similar levels of HDL cholesterol and triglycerides.

Table 3 and Figure 1 show the degree of glycaemic control and other CVRF according to diabetes duration. The results show that as diabetes duration increases, an increase in HbA_{1c} associated with a slight decrease of the percentage of cases with poorly controlled LDL is observed, but only in primary prevention. After 20 years of disease duration, an increase in cases of poorly controlled LDL was reported in patients with CVD (secondary prevention). Blood pressure levels remained stable throughout the course of the disease. Logistic regression model controlling for age, sex and CVD showed that diabetes duration was significantly related to glycaemic control [odds ratios (OR) 1.066, 95% CI: 1.050–1.082 per year) but not to blood pressure or LDL control. Using the same model, the escalation

Table 2. Population characteristics according to diabetes duration

	0–5 years	6–10 years	11–20 years	>20 years	*P*-value
N	1634	924	489	83	
Age ± SD	66.1 ± 12.2	68.9 ± 10.9	71.5 ± 10.3	74.6 ± 9.2	<0.001
Gender (%)					
Male	874 (53.3%)	475 (51.4%)	233 (47.6%)	29 (34.9%)	0.002
Female	760 (46.5%)	449 (48.6%)	256 (52.4%)	54 (65.1%)	
Body mass index (kg/m^2)	30.4 ± 5.16	30.2 ± 4.96	29.8 ± 5.05	29.0 ± 4.75	0.04
Smoking habit (%)					
No	1291(84.7%)	742 (86.8%)	415 (88.7%)	75 (93.8%)	0.02
Yes	234 (15.3%)	113 (13.2%)	53 (11.3%)	5 (6.3%)	
Creatinin (mg/dl)	1.16 ± 0.99	1.29 ± 1.18	1.16 ± 0.80	1.39 ± 1.30	0.01
Glomerular filtration (MDRD) (ml/minute)	79.9 ± 48.8	74.8 ± 30.9	74.3 ± 46.4	66.1 ± 27.0	0.003
GF>60 ml/minute	1090 (80.6%)	601 (75.5%)	297 (71.1%)	46 (63%)	<0.001
GF 60–45 ml/minute	130 (9.6%)	85 (10.7%)	63 (15.1%)	16 (21.9%)	
GF 45–30 ml/minute	40 (3.0%)	21 (2.6%)	25 (6.0%)	2 (2.7%)	
GF<30 ml/minute	93 (6.9%)	89 (11.2%)	33 (7.9%)	9 (12.3%)	
Albuminuria (mg/dl)	24.6 ± 56.5	39.2 ± 124	45.0 ± 125	21.7 ± 51.4	0.008
HbA_{1c} (%)	6.65 ± 1.47	6.97 ± 1.39	7.11 ± 1.45	7.32 ± 1.39	<0.001
SBP (mmHg)	136 ± 14.4	138 ± 15.0	138 ± 15.1	138 ± 13.9	0.02
DBP (mmHg)	77.3 ± 8.95	76.3 ± 8.78	74.7 ± 9.22	72.7 ± 8.86	<0.001
Total cholesterol(mg/dl)	197 ± 38.7	193 ± 38.5	189 ± 37.1	192 ± 35.6	<0.001
HDL cholesterol (mg/dl)	49.9 ± 13.2	50.3 ± 13.4	50.4 ± 13.4	53.5 ± 14.1	0.15
LDL cholesterol (mg/dl)	117 ± 33.6	114 ± 33.2	109 ± 30.4	109 ± 28.3	<0.001
Non-HDL colesterol (mg/dl)	147 ± 37.9	143 ± 37.5	138 ± 35.2	138 ± 36.9	<0.001
Triglycerides (mg/dl)	157 ± 134	144 ± 92.8	144 ± 99.4	147 ± 136	0.06
Diet only	493(30.2%)	157 (17.0%)	44 (9.0%)	3 (3.6%)	<0.001
Oral monotherapy	700 (42.8%)	404 (43.7%)	152 (31.1%)	20 (24.1%)	<0.001
Oral combined	274 (16.8%)	200 (21.6%)	126 (25.8%)	16 (19.3%)	<0.001
Insulin (± oral agents)	167 (10.3%)	163 (17.6%)	167 (34.2%)	44 (53.0%)	<0.001

Numeric variables are expressed as mean ± standard deviation. BMI, body mass index; MDRD, modification of diet in renal disease; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; LDL, low density lipoprotein; HDL, high density lipoprotein.

Table 3. Degree of glycaemic and other cardiovascular risk factors control according to diabetes duration

	Global	0–5 years	6–10 years	11–20 years	>20 years	*P* value
HbA_{1c} > 7%	997 (31.9%)	421 (25.8%)	326 (35.3%)	207 (42.3%)	43 (51.8%)	<0.001
BP > 140/90 mmHg	1240 (42.9%)	625 (41.6%)	381 (44.4%)	200 (44.4%)	34 (44.7%)	0.5
LDL > 130 mg/dl (PP)	630 (34.1%)	380 (36.9%)	177 (33.4%)	66 (26.8%)	7 (17.9%)	0.003
LDL > 100 mg/dl (SP)	389 (56.2%)	162 (58.7%)	120 (53.6%)	82 (51.9%)	25 (73.5%)	0.08
BMI >30 kg/m^2	1088 (42.3%)	566 (42.5%)	336 (43.6%)	165 (40.8%)	21 (31.3%)	0.24
Current smoker	405 (13.8%)	234 (15.3%)	113 (13.2%)	53 (11.3%)	5 (6.3%)	0.02

BMI, body mass index; BP, blood pressure; PP, primary prevention; SP, secondary prevention.

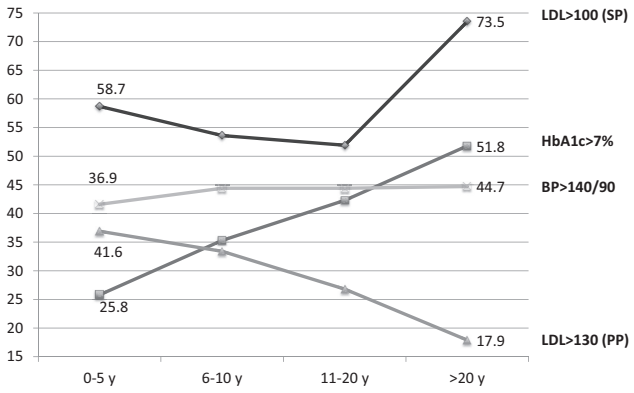


Figure 1. Control of cardiovascular risk factors according to diabetes duration.

of treatment was negatively related to good glycaemic control: any pharmacological treatment versus diet (OR 0.130; 95% CI: 0.093–0.180), oral drugs versus diet (0.193; 0.137–0.271); and insulin versus oral drugs (0.366; 0.301–0.445).

Table 4 summarizes the prevalence of microvascular as well as macrovascular complications according to disease progression. The results show that microvascular complications (retinopathy and microalbuminuria) increase significantly after 10 years of diabetes duration. Concerning macrovascular complications (IHD, stroke) the percentage of patients that do not present any (primary prevention) decreases as the duration of the disease increases. About 46% of the patients presented at least one macrovascular complication after 20 years of diabetes duration.

Discussion

The primary aim of this study was to analyze the evolution of the degree of metabolic control and CVRF in relation to the duration of T2DM in a large sample of people followed in a primary care setting of the Mediterranean area. The results show a progressive deterioration of glycaemic control: in the first 5 years since diagnosis mean HbA_{1c} values were 6.65% and progressively deteriorated reaching 7.32% after 20 years of disease duration that was confirmed by logistic regression (6.6% worsening per each year of duration). This phenomenon is likely to be attributed to the progressive loss of function of the pancreatic beta cell, despite the progressive increase in the use of combined antihyperglycaemic and insulin therapy. This phenomenon has already been observed in several studies such as that conducted by Mata-Cases *et al.* (22) in the same geographical region, where the average HbA_{1c} increased from 6.8% to 7.5% after 10 years of diabetes duration despite progressive increase in the use of combined oral treatments and insulin. In this population database study including 286.791 T2DM patients, glycaemic control worsened with the duration of the disease and the more complex steps of treatment (22). The authors interpreted these findings as a result of clinicians not prescribing drug treatment to well-controlled patients, while prescribing metformin to moderately well-controlled patients and combined oral agents or insulin-based treatment to less-controlled patients. On the other hand, this disappointing result is probably related to the fact that therapeutical changes are sometimes introduced after several years of uncontrolled HbA_{1c}, frequently above 8% (23,24).

In relation to other CVRF control, blood pressure did not significantly change with diabetes duration, but a slight decrease in diastolic blood pressure and an increase of combined antihypertensive therapies were observed. The mean LDL cholesterol in the total sample fell from 117 mg/dl in the first 5 years to 109 mg/dl after 20 years of diabetes duration (P = 0.08). In addition, a significant increase of the percentage of patients using lipid-lowering agents was observed (from 43.1% to 47%). This phenomenon is clearly observed in primary prevention patients where only 17.3% of those with over 20 years of duration have LDL > 130 mg/dl; however, in cases of secondary prevention there has been a significant increase of cases with LDL > 100 mg/dl after 20 years of duration (73.5%), which can only be attributed to the limited sample size in this subgroup (n = 34) since there has been a significant decline in lipid-lowering consumption.

To minimize the risk of specific complications of T2DM careful control of glycemia and as well as other CVRF is required. According to previous studies, glycaemic control is not achieved as often as desirable (15–19,25,26). However, in our study, in agreement with the results showed by Vinagre *et al.* (19), the results are positive. 68.1 % of patients presented $HbA_{1c} \leq 7\%$, 57.1 % had BP ≤ 140/90 mmHg and 65.9 % of the patients without a history of CVD maintain LDL cholesterol levels ≤ 130 mg/

Table 4. Chronic complications prevalence according to diabetes duration

	Global	0–5 years	6–10 years	11–20 years	> 20 years	*P*-value
Microvascular complications (%)						
Retinopathy	279 (15.3%)	84 (9.4%)	86 (15.8%)	88 (26.8%)	21 (39.6%)	<0.001
Microalbuminuria	214 (12.4%)	100(10.5%)	78 (13%)	57 (17.3%)	6 (10%)	<0.001
Macroalbuminuria	89 (4.6%)	30 (3.1%)	33 (5.5%)	22 (6.7%)	4 (6.7%)	<0.05
Macrovascular complications (%)						
Without CVD (primary prevention)	2304 (73.6%)	1304 (80%)	646 (70%)	309 (63.2%)	45 (54.2%)	<0.001
CVD (secondary prevention)						
IHD	353 (11.9%)	150 (9.8%)	131 (14.9%)	59 (12.7%)	13 (16%)	<0.001
Stroke	198 (6.7%)	74 (4.8%)	78 (8.9%)	40 (8.6%)	6 (7.8%)	<0.001
IHD + stroke	38 (1.2%)	11 (0.7%)	17 (1.8%)	8 (1.6%)	2 (2.4%)	<0.05

CVD, cardiovascular disease; IHD, ischaemic heart disease.

dl. These results are better when compared with those achieved in most studies and it is probable the reflection of the implementation of the MCC program in Catalonia since 1992 (18).

This study is part of a program of continuous quality improvement monitoring the management of these patients in ambulatory settings. Therefore, it is more focused on quality of care indicators than in purely clinical or epidemiological variables and therefore, such focus could represent a limitation of the study. Another possible limitation of the study is that centre participation was voluntary, therefore it could be hypothesized that only the most motivated centres for diabetes control participated in the assessments. However, the fact that the health provider responsible for data reviewing was motivated did not preclude that the remaining professionals of the centre were motivated in diabetes management.

In conclusion, diabetes duration was associated with a poorer glycaemic control, but, except in special situations, such variable had a limited role in blood pressure control or lipid profile in patients with T2DM. Recent trials suggest that intensive glucose control among people with long-standing T2DM has limited cardiovascular benefits, whereas an early treatment at the beginning, of the disease, as in the UKPDS study, may be associated with significant micro and macrovascular benefits through the so called 'legacy effect (14)'. As included in the new guidelines from the ADA and EASD proposed in 2012 (27), diabetes duration is one of the main aspects to take into account for establishing diabetes objectives. While in people with long-standing diabetes, less stringent objectives (8%–8.5%) are preferred, more stringent HbA_{1c} targets (e.g. 6.0%–6.5%) might be considered in selected patients (with short disease duration, long-life expectancy, no significant CVD) if the goal can be achieved without significant hypoglycemia or other adverse effects of treatment (27).

Acknowledgements

All the members of the GEDAPS group, physicians and nurses, without whose commitment to quality of care it would not have been possible to carry out this study. To Sofia Perea, Pharm D, PhD, who provided medical writing (see Appendix).

Declaration

Funding: The GEDAPS 2007 evaluation has received financial support from Merck Sharp & Dohme Spain and the Fundació d'Atenció Primària. Both sponsors have played no role in the conduction of the study. Ethical approval: the study design and the Gedaps Quality Improvement Programme were presented and approved by the Consell Assessor de la Diabetis (Advisory Board on Diabetes) of the Health Department of the Autonomous government in Catalunya that behaved as Institutional Review Board.
Conflict of interest: none.
Authors' contributions: JFN, PRO, BBB, ARP, GCdT, MMC participated in the conception and design of study, acquisition of data, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, and final approval of the version to be submitted. JFN is the guarantor of the manuscript, taking responsibility for the contents of the article.

References

1. Soriguer F, Goday A, Bosch-Comas A *et al.* Prevalence of diabetes mellitus and impaired glucose regulation in Spain: the Di@bet.es Study. *Diabetologia* 2012; **55**: 88–93.
2. Nolan CJ, Damm P, Prentki M. Type 2 diabetes across generations: from pathophysiology to prevention and management. *Lancet* 2011; **378**: 169–81.
3. American Diabetes Association. Standards of medical care in diabetes 2013. *Diabetes Care* 2013: **36** (suppl 1): S11–66.
4. Gaede P, Lund-Andersen H, Parving HH, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. *N Engl J Med* 2008; **358**: 580–91.
5. Fox CS, Sullivan L, D'Agostino RB Sr, Wilson PW; Framingham Heart Study. The significant effect of diabetes duration on coronary heart disease mortality: the Framingham Heart Study. *Diabetes Care* 2004; **27**: 704–8.
6. Seshasai SR, Kaptoge S, Thompson A *et al.* Diabetes mellitus, fasting glucose, and risk of cause-specific death. Emerging Risk Factors Collaboration. *N Engl J Med* 2011; **364**: 829–41.

7. Wannamethee SG, Shaper AG, Whincup PH, Lennon L, Sattar N. Impact of diabetes on cardiovascular disease risk and all-cause mortality in older men: influence of age at onset, diabetes duration, and established and novel risk factors. *Arch Intern Med* 2011; **171**: 404–10.
8. Stevens RJ, Kothari V, Adler AI, Stratton IM; United Kingdom Prospective Diabetes Study (UKPDS) Group. The UKPDS risk engine: a model for the risk of coronary heart disease in Type II diabetes (UKPDS 56). *Clin Sci (Lond)* 2001; **101**: 671–9.
9. Kengne AP, Patel A, Marre M *et al.*; ADVANCE Collaborative Group. Contemporary model for cardiovascular risk prediction in people with type 2 diabetes. *Eur J Cardiovasc Prev Rehabil* 2011; **18**: 393–8.
10. Shah AS, Dolan LM, Kimball TR *et al*. Influence of duration of diabetes, glycemic control, and traditional cardiovascular risk factors on early atherosclerotic vascular changes in adolescents and young adults with type 2 diabetes mellitus. *J Clin Endocrinol Metab* 2009; **94**: 3740–5.
11. Meyer MF, Lieps D, Schatz H, Klein HH, Pfohl M. Influence of the duration of type 2 diabetes on early functional and morphological markers of atherosclerosis compared to the impact of coexisting classic cardiovascular risk factors. *Exp Clin Endocrinol Diabetes* 2008; **116**: 298–304.
12. Cano JF, Baena-Diez JM, Franch J *et al.*; REGICOR and GEDAPS Investigators. Long-term cardiovascular risk in type 2 diabetic compared with nondiabetic first acute myocardial infarction patients: a population-based cohort study in southern Europe. *Diabetes Care* 2010; **33**: 2004–9.
13. Hu FB, Stampfer MJ, Solomon CG *et al*. The impact of diabetes mellitus on mortality from all causes and coronary heart disease in women: 20 years of follow-up. *Arch Intern Med* 2001; **161**: 1717–23.
14. UK Prospective Diabetes Study (UKPDS) Group; Holman RR, Sanjoy PK, Bethel MA, Matthews DR, Neil MA. 10-Year Follow-up of intensive glucosecontrol in Type 2 diabetes. *N Engl J Med* 2008; **359**: 1577–89.
15. Morato Griera J, Franch Nadal J, Carrillo Muñoz R*et al*. Chronology of complications from diabetes in adults. The Raval Sud study. *An Med Interna* 1995; **12**: 431–7.
16. Orozco-Beltrán D, Gil-Guillen VF, Quirce F *et al.*; Collaborative Diabetes Study Investigators. Control of diabetes and cardiovascular risk factors in patients with type 2 diabetes in primary care. The gap between guidelines and reality in Spain. *Int J Clin Pract* 2007; **61**: 909–15.
17. Franch Nadal J, Artola Menéndez S, Diez Espino J, Mata Cases M; en representación de la Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud. The evolution of quality care indicators of patients with type 2 diabetes in the Spanish primary care (1996-2007). The RedGEDAPS quality of care program. *Med Clin (Barc)* 2010; **135**: 600–7.
18. Mata-Cases M, Roura-Olmeda P, Berengué-Iglesias M *et al.*; Diabetes Study Group in Primary Health Care (GEDAPS: Grup d'Estudi de la Diabetis a l'Atenció Primària de Salut, Catalonian Society of Family and Community Medicine). Fifteen years of continuous improvement of quality care of type 2 diabetes mellitus in primary care in Catalonia, Spain. *Int J Clin Pract* 2012; **66**: 289–98.
19. Vinagre I, Mata-Cases M, Hermosilla E *et al*. Control of glycemia and cardiovascular risk factors in patients with type 2 diabetes in primary care in Catalonia (Spain). *Diabetes Care* 2012; **35**: 774–9.
20. Cano Pérez JF, Franch Nadal J, Mata Cases M. *y miembros de los grupos GEDAPS (Grupo de Estudio de la Diabetes en Atención Primaria de Salud) de España. Guía de tratamiento de la diabetes tipo 2 en atención primaria. Recomendaciones clínicas con niveles de evidencia*. 2004; 4ª edición. Madrid: Elsevier.
21. Programa de mejora de la calidad redGedaps. *Evaluación de la atención a la diabetes en atención primaria*. http://www.redgdps.org/index.php?idregistro=259 (accessed on 31 March 2014).
22. Mata-Cases M, Mauricio D, Vinagre I *et al*. Treatment of Hyperglycaemia in Type 2 Diabetic Patients in a Primary Care Population Database in a Mediterranean Area (Catalonia, Spain). *J Diabetes Metab*. 2014; **5**: 338.
23. Conthe P, Mata M, Orozco D *et al*. Degree of control and delayed intensification of antihyperglycaemic treatment in type 2 diabetes mellitus patients in primary care in Spain. *Diabetes Res Clin Pract* 2011; **91**: 108–14.
24. Mata-Cases M, Benito-Badorrey B, Roura-Olmeda P *et al.*; GEDAPS (Primary Care Group for the study of Diabetes) of the Catalonian Society of Family and Community Medicine. Clinical inertia in the treatment of hyperglycemia in type 2 diabetes patients in primary care. *Curr Med Res Opin* 2013; 29: 1495–502.
25. Liebl A, Mata M, Eschwège E; CODE-2 Advisory Board. Evaluation of risk factors for development of complications in type II diabetes in Europe. *Diabetologia* 2002; **45**: S23–8.
26. De la Calle H, Costa A, Dıez-Espino J, Franch J, Goday A. Evaluacion del cumplimiento de los objetivos de control metabolico de la diabetes mellitus tipo 2. Estudio TranSTAR. *Med Clin (Barc)* 2003; **120**: 446–50.
27. Inzucchi SE, Bergenstal RM, Buse JB *et al.*; American Diabetes Association (ADA); European Association for the Study of Diabetes (EASD). Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care* 2012; **35**: 1364–79.

Appendix

List of participating investigators in the GEDAPS 2007 Evaluation

Mª Josepa Arasa-Fava, Joan Francesc Barrot-de-la-Puente, Belén Benito-Badorrey, Mª Dolors Berenguer-Iglesias, Martí Birulés-Pons, Isabel Bobé-Molina, Dolors Boix-Pujol, Montserrat Boneu-Castells, Mª Remei Bosch-Costabella, Montserrat Brugada-Mir, Magda Bundó-Vidiella, Ricard Carrillo-Muñoz, Carmen Ciria-Mallada, María de-Ciurana-Gay, Francesc Xavier Cos-Claramunt, Pilar Cosculluela-Torres, Engracia Costa-Atienza, Pilar Enseñat-Grau, Assumpta Farràs-Mas, Eugeni Fau-Montllor, Pilar Font-Roura, Pilar Franco-Comet, Isabel García-Villena, Josep Mª Garrido-Martín, Jorge Gentille-Lorente, Rosa Maria Gimbert-Ràfols, Joan Carles González-Pastor, Clementina Gonzalez-Rosua, Neus Gregori-Ortiz, Mª Cruz Guzmán-Bonilla, Juan Herreros-Melenchón, Cristina Laserna-Jiménez, Carmen Lecumberri-Pomar, Montserrat Ledesma-Joanmiquel, Judit Llussà-Arboix, Regina López-López, Mª Victoria Marina-Ortega, José Antonio Martín-García, Ana I. Martínez-Asensio, Daniel Martínez-Laguna, Pilar

Martínez-Marco, Manel Mata-Cases, Ana Menal-García, Mª Angeles Méndez-Trías, José Mercader-Coma, F. Xavier Mestres-Gallinat, Rosa Mar de-Miguel-Pérez, Xavier Mundet-Tuduri, Marifé Muñoz-Grimaldo, Rosa Blanca Muñoz-Muñoz, Isabel Otzet-Gramunt, Pilar Pallarés-Perna, María Pastoret-Descamps, Ramón Pujol-Martínez, Mónica Rodríguez-Barniol, José Osvel Rodríguez-Barrios, Antonio Rodríguez-Poncelas, Olivia Roig-Calvet, Pilar Roura-Olmeda, Laura Rubio-Pérez, Montserrat Rubio-Villar, Rou Sánchez-Collado, M. Carmen Soldado-Ordóñez, Àngels Sieira-Ribot, Ana Mª Suárez-Sanjuas, Marta Serra-Laguarta, Marta Torné-Coll, Anna Torné-Coromina, Cristina Verdera-Benedicto, Elena Villanueva-Santamaría

4.5 Quinto Artículo

Control de la glucemia y tendencias en el tratamiento antidiabético en pacientes con Diabetes tipo 2 en Centros de Atención Primaria durante el período 2007 a 2013 en Catalunya: Un estudio poblacional

British Medical Journal Open, 2016.

BMJ Open

Glycaemic control and antidiabetic treatment trends in primary care centres in patients with type 2 diabetes mellitus during 2007–2013 in Catalonia: a population-based study

Manel Mata-Cases,[1,2,3] Josep Franch-Nadal,[1,2,4] Jordi Real,[1,5] Dídac Mauricio[1,2,6]

To cite: Mata-Cases M, Franch-Nadal J, Real J, *et al*. Glycaemic control and antidiabetic treatment trends in primary care centres in patients with type 2 diabetes mellitus during 2007–2013 in Catalonia: a population-based study. *BMJ Open* 2016;**6**: e012463. doi:10.1136/bmjopen-2016-012463

► Prepublication history and additional material is available. To view please visit the journal (http://dx.doi.org/10.1136/bmjopen-2016-012463).

Received 29 April 2016
Revised 3 August 2016
Accepted 13 September 2016

For numbered affiliations see end of article.

Correspondence to
Dr Dídac Mauricio;
didacmauricio@gmail.com

ABSTRACT

Objectives: To assess trends in prescribing practices of antidiabetic agents and glycaemic control in patients with type 2 diabetes mellitus (T2DM).

Design: Cross-sectional analysis using yearly clinical data and antidiabetic treatments prescribed obtained from an electronic population database.

Setting: Primary healthcare centres, including the entire population attended by the Institut Català de la Salut in Catalonia, Spain, from 2007 to 2013.

Participants: Patients aged 31–90 years with a diagnosis of T2DM.

Results: The number of registered patients with T2DM in the database was 257 072 in 2007, increasing up to 343 969 in 2013. The proportion of patients not pharmacologically treated decreased by 9.7% (95% CI −9.48% to −9.92%), while there was an increase in the percentage of patients on monotherapy (4.4% increase; 95% CI 4.16% to 4.64%), combination therapy (2.8% increase; 95% CI 2.58% to 3.02%), and insulin alone or in combination (increasing 2.5%; 95% CI 2.2% to 2.8%). The use of metformin and dipeptidyl peptidase-IV inhibitors increased gradually, while sulfonylureas, glitazones and α-glucosidase inhibitors decreased. The use of glinides remained stable, and the use of glucagon-like peptide-1 receptor agonists was still marginal. Regarding glycaemic control, there were no relevant differences across years: mean glycated haemoglobin (HbA1c) value was around 7.2%; the percentage of patients reaching an HbA1c≤7% target ranged between 52.2% and 55.6%; and those attaining their individualised target from 72.8% to 75.7%.

Conclusions: Although the proportion of patients under pharmacological treatment increased substantially over time and there was an increase in the use of combination therapies, there have not been relevant changes in glycaemic control during the 2007–2013 period in Catalonia.

Strengths and limitations of this study

- The main strength of the study is the use of a large outpatient database that is indicative of the trends of general practitioners' practices in a real-life clinical setting.
- However, this was a retrospective study participant to errors in data recording or missing values.
- We were not able to assess whether the change in prescribed treatments over time was driven by patients' needs and characteristics (eg, prior low tolerability or effectiveness), and we cannot therefore claim a causal effect.
- We could not assess whether doses of pharmacological treatments were appropriately chosen, and we did not consider data on prescriptions within the same therapeutic class.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a highly prevalent chronic disease at risk of chronic microvascular and macrovascular complications when glycaemic control is suboptimal.[1] Although diet and lifestyle changes are initially effective, most patients will need an oral glucose-lowering agent to better control blood glucose levels, and most will eventually need multiple therapies as the disease progresses.[2] The pharmacological armamentarium to treat hyperglycaemia in T2DM has changed substantially over the past 20 years with the development of new therapeutic agents, such as insulin secretagogues (glinides), thiazolidinediones, incretins (glucagon-like peptide-1 receptor agonists (GLP-1ra) and dipeptidyl peptidase-IV inhibitors (DPP4i)), sodium-glucose transporter-2 inhibitors, fixed-dose combinations, and also with the advent of

insulin analogues.[3] This, together with changing treatment recommendations advocating for an intense glycaemic control in early stages of the disease,[4 5] makes drug choice increasingly challenging, and it has driven substantial changes in current prescribing practices with wide variations between countries depending on each therapeutic class.[6–17]

General practice databases are a reliable and rich source of information from the general population, and therefore a valuable tool to study medical practice in the community.[18] In Catalonia, Spain, such an electronic general practice database is available for researchers (Information System for the Development of Research in Primary Care (SIDIAP)), and it has been previously used to conduct several observational studies to assess different aspects of the natural history and treatment of T2DM in our autonomous region.[19–26]

In the present study, we aimed to examine prescribing patterns for antidiabetic treatment in primary care in Catalonia between 2007 and 2013 using SIDIAP data, and how changes impacted the degree of attained glycaemic control over time.

MATERIALS AND METHODS

Design

This was a cross-sectional, retrospective study using the SIDIAP database, which started in 2006 and stores data from electronic medical records. The database contains anonymised longitudinal patient information obtained from the electronic clinical records using specific software (Electronic Clinical station in Primary Care, eCAP) developed by the institution and used since 2001 by all of the 274 primary care centres pertaining to the Catalan Health Institute (ICS), which attends 80% of the total population (about 5.835 million patients) in Catalonia.

Data extraction

Data from patients aged 31 to 90 years with a diagnosis of T2DM (by means of the International Classification of Diseases, 10th Revision (ICD-10) codes E11 or E14) were obtained from the SIDIAP database for the years 2007–2013. Data were extracted for patients for each particular year. As a dynamic database, new patients enter when a new diagnosis of T2DM is recorded, and patients are withdrawn when a death occurs or the patient moves to another healthcare region not served by the Catalonian Health Institute. Registered variables included: age; gender; time since diagnosis; the presence of comorbidities (ICD-10 codes); and the most recent value for each year of body mass index (BMI) and mean glycated haemoglobin (HbA1c). Before 1 January 2010, between 50% and 70% of laboratories in Spain expressed HbA1c values using the Japanese Diabetes Society/Japanese Society for Clinical Chemistry criteria (JDS/JCC; normal range 3.9–5.7%),[27] and these values were not converted to the internationally defined Diabetes Control and Complications Trial/National Glycohemoglobin Standardization Program (DCCT/NGSP) calibration criteria (normal range 4–6%). All values from 1 January 2010 onwards were expressed using DCCT/NGSP criteria.

The prescribed antidiabetic treatments for each patient and year were extracted from prescription-invoicing and pharmacy-invoicing data provided by the Catalan Health Service (CatSalut), which are incorporated yearly into the SIDIAP database. Glucose-lowering agents included the use of insulin and non-insulin antidiabetic drugs (NIADs) marketed in Spain during the study period, namely metformin, sulfonylureas, glinides, glitazones, DPP4i, GLP-1ra and α-glucosidase inhibitors (AGI). The first DPP4i marketed in Spain was sitagliptin (2007) followed by vildagliptin (2007), saxagliptin (2010) and linagliptin (2012). For GLP-1ra, daily exenatide appeared in 2007, and liraglutide in 2011. Treatment steps were categorised as non-pharmacological treatment, an NIAD in monotherapy, NIADs in combination (2 or more without insulin), insulin alone or insulin in combination with NIADs.

Statistical analysis

Descriptive analyses by year are presented as mean and SD for continuous variables, and percentages for categorical variables. Changes across the study period were evaluated through the absolute overall increase and the 95% CIs using the normal approximation. We used three different criteria for adequate glycaemic control: mean HbA1c≤7%, as widely recommended and accepted; HbA1c≤8%, as recommended by our institution during the study period (ICS);[28 29] and individualised goals based on age, duration of the disease, and presence of serious complications or comorbidities, as proposed by the Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud 2014 (Red-GDPS).[30] All statistical calculations were performed using StataCorp 2009 (Stata Statistical Software: Release 11. College Station, Texas, USA: StataCorp, LP).

RESULTS

Patients' characteristics

The total number of registered patients with T2DM in our database was 257 072 in 2007, increasing up to 343 969 in 2013 (a total increase of 86 897 cases) (table 1). The patients' mean age did not vary substantially over the years (overall increase 1.20 years; 95% CI 1.14 to 1.26 years), and nor did the mean BMI or the number of obese patients (overall decrease 0.08 kg/m^2; 95% CI −0.11 to −0.05 kg/m^2; overall 0.043% decrease in obese patients; 95% CI −0.12% to −0.74%), but we observed a small progressive increase in the proportion of male patients (overall increase 2.15%; 95% CI 1.90% to 2.40%), and also a gradual increase in the mean duration of the disease (overall increase 2.40 years; 95% CI 2.37 to 2.43 years).

Prescribing pattern of antidiabetic drugs

The proportion of patients not receiving antidiabetic drugs decreased by 9.7% (95% CI −9.48% to −9.92%)

Table 1 Demographic, clinical characteristics and degree of glycaemic control of patients with T2DM by year

	2007 N=257 072	2008 N=271 690	2009 N=286 019	2010 N=301 144	2011 N=317 215	2012 N=331 317	2013 N=343 969	Change 2007–2013 (95% CI)
Age, mean (SD), years	67.7 (11.7)	67.9 (11.8)	68.1 (11.8)	68.2 (11.9)	68.4 (12.0)	68.6 (12.1)	68.9 (12.1)	1.20 (1.14 to 1.26)
Males, %	52.2	52.7	53.2	53.6	53.9	54.1	54.3	2.15 (1.90 to 2.40)
T2DM duration, mean (SD), years	5.4 (5.3)	5.9 (5.3)	6.3 (5.3)	6.7 (5.4)	7.0 (5.5)	7.4 (5.6)	7.8 (5.6)	2.40 (2.37 to 2.43)
BMI, mean (SD), kg/m^2	30.1 (5.0)	30.1 (5.0)	30.1 (5.0)	30.1 (5.0)	30.1 (5.1)	30.0 (5.1)	30.0 (5.1)	−0.08 (−0.11 to −0.05)
Obesity (BMI>30 kg/m^2), %	45.6	45.5	45.3	45.7	45.3	45.1	45.1	−0.043 (−0.12 to −0.74)
HbA1c*, mean (SD), %	7.16 (1.46)	7.23 (1.48)	7.25 (1.47)	7.19 (1.40)	7.20 (1.36)	7.30 (1.35)	7.24 (1.35)	0.08 (0.07 to 0.09)
HbA1c≤7%, %	54.9	52.8	52.2	55.1	55.6	52.6	55.2	0.29 (−0.02 to 0.60)†
HbA1c≤8%*, %	78.9	77.8	77.9	79.3	79.6	78.4	79.6	0.64 (0.39 to 0.89)
Individualised HbA1c target‡, %	75.4	73.2	72.8	74.8	75.4	73.7	75.7	1.15 (0.88 to 1.42)

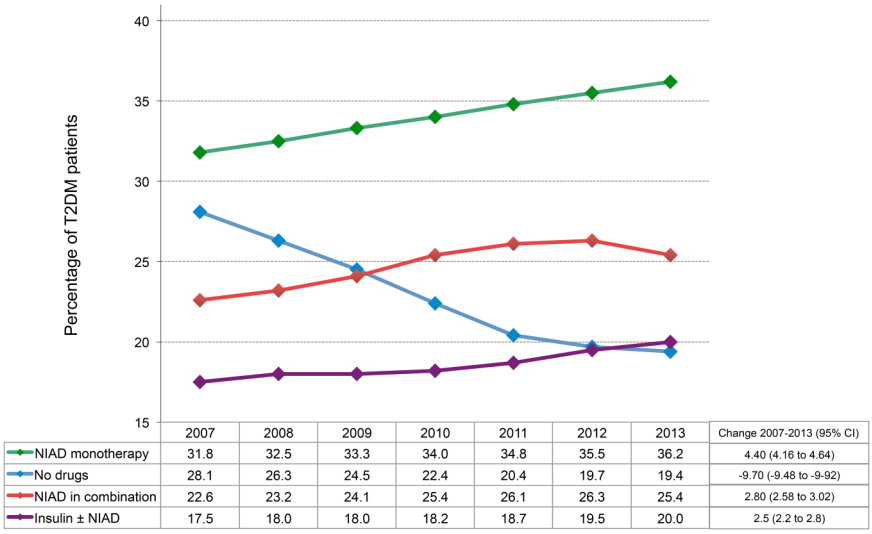
*Cut-off stated by the ICS.
†The CI contains the null change (0), and therefore it is not statistically significant.
‡On the basis of the 2014 algorithm of the Red-GDPS.
BMI, body mass index; HbA1c, glycated haemoglobin; ICS, Institut Català de la Salut; Red-GDPS, Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud; T2DM, type 2 diabetes mellitus.

from 2007 to 2013, while the percentage of patients receiving pharmacological antidiabetic treatment was 71.9% in 2007, and this proportion increased annually and was 81.6% in the last year of the study, showing an overall 9.7% increase over the study period. The proportion of patients receiving each type of therapy across the time period 2007–2013 is shown in figure 1. The most frequent prescription was an NIAD in monotherapy, the use of which increased 4.4% (95% CI 4.16% to 4.64%) from 2007 to 2013, followed by NIADs in combination (increasing 2.8%; 95% CI 2.58% to 3.02%), and insulin alone or in combination (increasing 2.5%; 95% CI 2.2% to 2.8%). Among NIADs, the most frequently used drugs were metformin and sulfonylureas, although the prescription rate of metformin increased notably across time (19.5%; 95% CI 19.25% to 19.75%), whereas it decreased gradually in the case of sulfonylureas (8.20%; 95% CI −7.97% to −8.43%) (figure 2). As for the use of the rest of the available options, only the prescription of DPP4i increased substantially up to 13.2% in 2013 (95% CI 13.09% to 13.31%), while the use of glitazones, glinides, AGI and GLP-1ra remained low. Glitazones and AGI prescriptions even decreased with time: glitazones an overall 2.9% (95% CI −2.82% to −2.98%) and AGI 2.70% (95% CI −2.62% to −2.78%). Finally, glinides and GLP-1ra only increased slightly over time: 0.8% in the case of glinides (95% CI 0.69% to 0.91%) and 0.9% in the case of GLP-1ra (95% CI 0.87% to 0.93%).

Evolution of the degree of glycaemic control

The mean standardised HbA1c value was around 7.2%, with no clinically relevant differences across years (table 1). Moreover, the proportion of patients attaining a glycaemic target of HbA1c≤7% ranged from 52.2% to 55.6% (overall change 0.29%; 95% CI −0.02% to 0.60%), and the ICS target ≤8% ranged from 77.8% to 79.6% (overall change 0.64%; 95% CI 0.39% to 21.42%), with no clinically relevant changes across years (table 1). Moreover, the percentage of patients attaining their individualised HbA1c target ranged increased by only 1.15% (95% CI 0.88% to 1.42%) (table 1). Finally, the analysis of the evolution of the attained glycaemic control according to different HbA1c intervals also showed that there were no remarkable changes among years in any case (figure 3). Of note, the group of patients who were less likely to achieve the corresponding glycaemic target included those younger than 65 years, without comorbidities, and duration of T2DM≤15 years (range 50.8–55.1%) (see online supplementary table S1).

The evolution of the mean Hb1Ac levels according to each step of treatment and duration of T2DM is shown in figure 4 and online supplementary table S2. Considering all antidiabetic treatments, there was a progressive worsening of HbA1c levels as the disease duration increased, but this worsening was in fact only observed among patients treated with insulin alone or in combination with NIADs. Conversely, glycaemic values



	2007	2008	2009	2010	2011	2012	2013	Change 2007-2013 (95% CI)
NIAD monotherapy	31.8	32.5	33.3	34.0	34.8	35.5	36.2	4.40 (4.16 to 4.64)
No drugs	28.1	26.3	24.5	22.4	20.4	19.7	19.4	-9.70 (-9.48 to -9-92)
NIAD in combination	22.6	23.2	24.1	25.4	26.1	26.3	25.4	2.80 (2.58 to 3.02)
Insulin ± NIAD	17.5	18.0	18.0	18.2	18.7	19.5	20.0	2.5 (2.2 to 2.8)

Figure 1 Percentage of patients with T2DM at each step of antidiabetic treatment. NIAD, non-insulin antidiabetic drug; T2DM, type 2 diabetes mellitus.

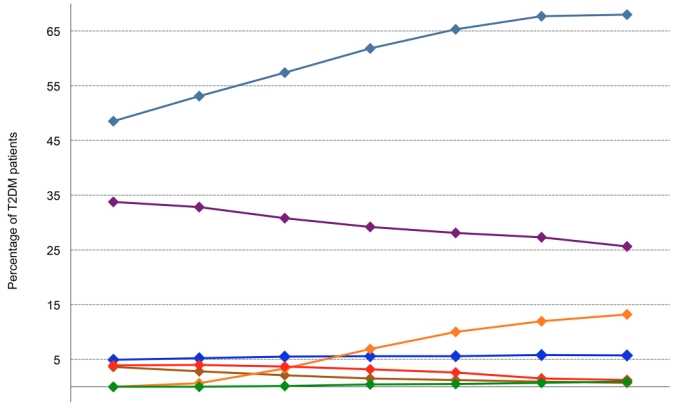
in patients not pharmacologically treated or on NIADs improved as T2DM duration increased, with no substantial differences across the study period.

DISCUSSION

This cross-sectional descriptive study is, to the best of our knowledge, the first to assess trends in the prescribing practices of antidiabetic drugs in relation to the level of attained glycaemic control between 2007 and 2013 in a primary healthcare setting in Spain.

A gradual increase in the prescription of antidiabetic agents has been previously reported in Spain[16 17] and in studies conducted worldwide throughout the same or overlapping years as in our study.[6–8 10–12 31 32] An increase in the use of combinations of oral antidiabetic drugs (OADs) has been consistently observed in several studies from different countries,[6 7 9 11 17 31] but the trends in its use as monotherapy vary among reports, with some describing an overall increase over time,[11 13 32] and others a progressive decrease.[6 9 31] Moreover, while the number of prescriptions of insulin in combination with an OAD has been shown to increase with time,[6 7 11] the use of insulin alone has been reported to remain stable,[17 33] to decrease[6 11 31] or even to increase.[32] Differences between drug schemes and studies may be attributable to health policy variations across countries, local professional expertise, physician's personal choice, study setting (eg, hospital vs primary care or insurance claims vs national database), or inclusion of both patients with T1DM and T2DM in some cases.

Both an increase in the use of metformin and a decrease in the use of sulfonylureas have been consistently reported by other groups.[6–9 11–13 15 17 31–33] This decline could be related to the recent recommendation of cautionary use in the elderly,[34] their worse safety profile, associated weight gain, unclear role in reducing long-term complications and/or to the availability of safer new therapeutic options.[5] Although a decrease in glinides and AGIs use has been reported in Spain, Japan



	2007	2008	2009	2010	2011	2012	2013	Change 2007-2013 (95% CI)
Metformin	48.5	53.1	57.4	61.8	65.3	67.7	68.0	19.50 (19.25 to 19.75)
Sulfonylureas	33.8	32.8	30.8	29.2	28.1	27.3	25.6	-8.20 (-7.97 to -8.43)
Glinides	4.9	5.2	5.5	5.6	5.6	5.8	5.7	0.80 (0.69 to 0.91)
AGI	3.6	2.8	2.1	1.5	1.2	0.9	0.7	-2.90 (-2.82 to -2.98)
DPP4i	0.0	0.6	3.3	6.9	10.0	12.0	13.2	13.20 (13.09 to 13.31)
Glitazones	3.9	4.0	3.7	3.2	2.6	1.5	1.2	-2.70 (-2.62 to -2.78)
GLP-1ra	0.0	0.0	0.1	0.4	0.5	0.7	0.9	0.90 (0.8 to 0.93)

Figure 2 Percentage of patients having non-insulin antidiabetic drug prescriptions (alone or in combination). AGI, α-glucosidase inhibitors; DPP4i, dipeptidyl peptidase-IV inhibitors; GLP-1ra, glucagon-like peptide-1 receptor agonists; T2DM, type 2 diabetes mellitus.

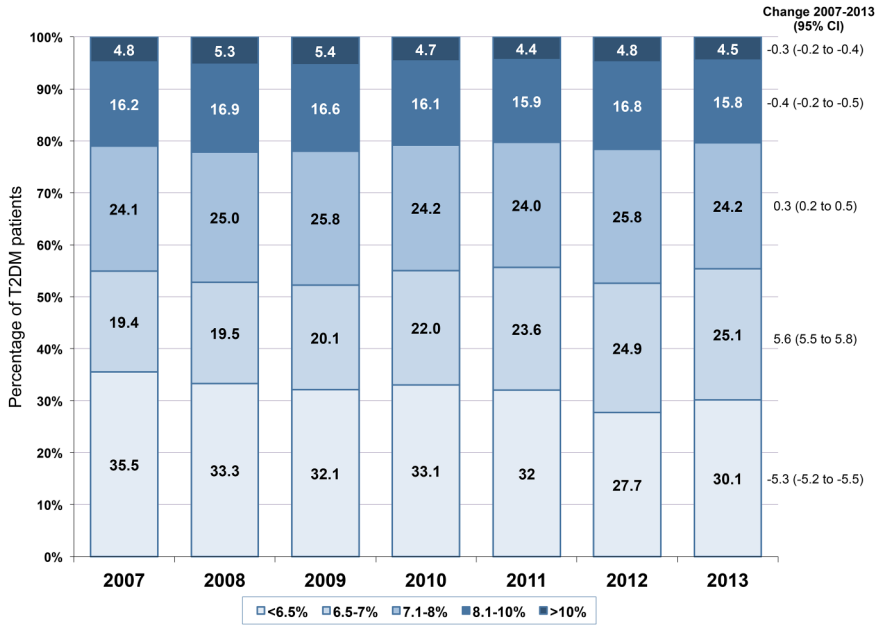


Figure 3 Percentage of patients achieving glycaemic control according to HbA1c intervals. HbA1c, glycated haemoglobin; T2DM, type 2 diabetes mellitus.

and in the UK,[11 15 17 33] in our study the number of glinides prescriptions remained stable, which could be explained by the fact that in spite of their risk of hypoglycaemia,[5] they are the most used therapeutic class in patients with chronic kidney disease.[25] The decrease in AGIs might be explained by the high frequency of gastrointestinal side effects that led to the recommendation to only use them in people unable to use other oral glucose-lowering medications.[35] The decrease in the use of glitazones has been consistently documented in several studies that included data after 2007,[8 9 11–13 15 17 31–33] when the first regulatory warnings and the results of a meta-analysis alerted clinicians to cardiovascular risk associated with rosiglitazone,[36 37] and to a risk of bladder cancer with pioglitazone in 2011.[38] Both side effects have been recently ruled out,[37 39] but the influence of these alarms, together with weight gain, the risk of heart failure and the increased risk of bone fractures in women observed with this class of drugs, has limited its use. The marginal use of GLP-1ra in our study is similar to that of a recent study conducted in the UK,[15] but in contrast with a substantial increase documented in another region of Spain,[17] Ireland and the USA.[9 13] The administrative restrictions and negative economic incentives of our institution (ICS) for the prescription of GLP-1ar may have contributed to the limited use of this therapeutic class. Finally, DPP4i the class of newly developed NIADs with the greatest increase in use, which is in agreement with other reports conducted worldwide.[9 11–13 17 31–33] This rapid adoption, mainly as an alternative to sulfonylureas, may respond to the lower risk of hypoglycaemia, its neutral effects on body weight and also the greater convenience of an oral treatment instead of the need of injections for GLP-1ar or insulin.[40] In summary, although a plethora of hypoglycaemic agents are currently available with a substantially comparable effect in terms of glycaemic control, the physician's choice should be personalised based on patient's characteristics such as age, risk factors and comorbidities.

When we assessed the attained glycaemic control based on the treatment step, we found that patients on NIADs in combination or on insulin with or without an NIAD were the ones with the highest HbA1c levels. This is in line with the results of several studies showing a delay in treatment intensification in patients already on combination therapies whose control of blood glucose remained or became inadequate.[35 41] Moreover, we found that about half of the patients had HbA1c levels ≤7% as recommended by clinical guidelines, about 80% below the 8% recommended by our institution (ICS), and about 75% below the individualised goal recommended by the Red-GDPS. Our figures are slightly worse than the ones reported by a study conducted in the Basque country in Spain for patients achieving HbA1c levels ≤7% (about 64.1% of them), but similar to their 85.5% of patients achieving a ≤8% target.[42] Finally, and confirming previous analyses, the subgroup with the highest proportion of patients attaining appropriate individualised glycaemic control was the one of patients older than 75 years,[23] while patients younger than 65 years without comorbidities or serious complications and T2DM duration ≤15 years were less likely to achieve the corresponding individualised glycaemic control target. This could be explained by a higher proportion of obesity among younger patients, a longer survival among adequately controlled older patients, or by an easier to reach glycaemic goal in the elderly (≤8% vs ≤7%). More importantly, our results confirm that an individualised therapeutic approach considerably increases the chances of attaining adequate glycaemic control and provides effective T2DM care.[43] However, one of the most striking

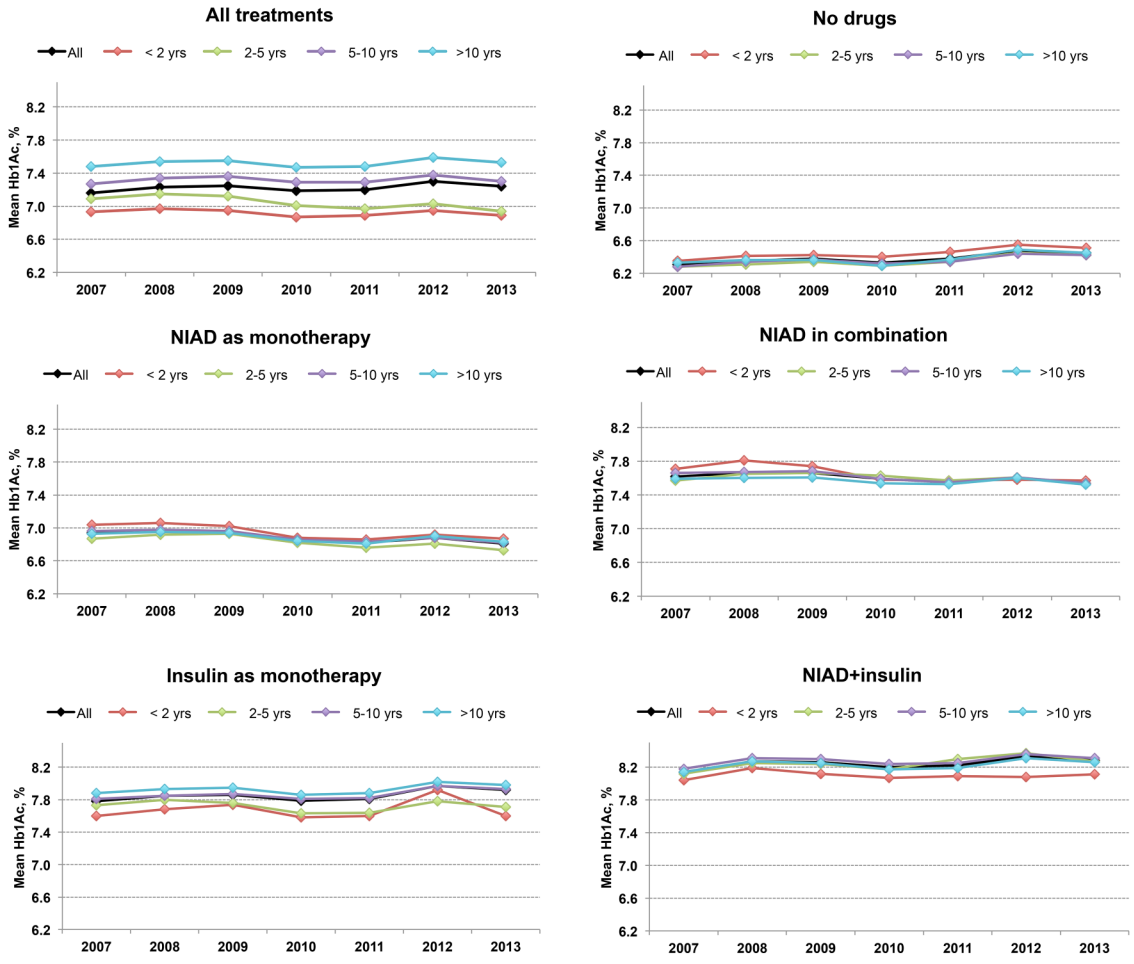


Figure 4 Evolution of mean HbA1c according to the different steps of antidiabetic treatment and T2DM duration. HbA1c, glycated haemoglobin; NIAD, non-insulin antidiabetic drug; T2DM, type 2 diabetes mellitus.

findings of our study was that there were no relevant changes across years, meaning that in spite of the overall observed gradual increase in pharmacological treatments along the study there was no obvious trend towards an increase in the proportion of patients with an adequate HbA1c target whatever the used cut-off, and the mean HbA1c values did not significantly change over time regardless of the treatment step. There are few reports on how the evolution in the prescription pattern of antidiabetic drugs affects the level of attained glycaemic control, but our results are in contrast with a study conducted in Japan showing that the rate of patients achieving the ≤7% goal significantly improved together with the progressive increase in the proportion of pharmacological treatments.[11] However, a very recent study conducted in Canada reported that the mean HbA1c values in older patients even increased slightly over a 5-year period in spite of the overall increase in the use of antidiabetic treatment.[14] Our results seriously question the ICS threshold to maintain HbA1c levels ≤8% for all patients, giving general practitioners financial incentives if this goal is attained, without taking into account age, diabetes duration or the presence of comorbidities. This threshold was established to avoid overtreatment—especially in the elderly—but can be counterproductive in younger patients. Certainly, about 25% of patients had HbA1c between 7.1% and 8%, and were therefore at potential risk of suboptimal management or undertreatment until they reached this value, especially in people aged under 65 years. Thus, this institutional policy potentially contributes to therapeutic inertia, defined as a delay in treatment intensification among patients with poor glycaemic control. Clinical inertia has been documented in primary care settings,[44 45] and a study conducted in Catalonia in 2007 in a sample of 2783 patients with T2DM reported that therapeutic inertia was present in 33.2% of cases, and treatment intensification was implemented in patients with a mean HbA1c of 8.4%,[41] which is far above the 8% threshold established by the institution. On the other hand, most family physicians find that patients treated with an NIAD combination but needing intensification with insulin or GLP-1ar, and those already on insulin needing optimisation with multiple insulin doses or the addition of a GLP-1ar, are difficult to manage or they have reasonable safety concerns. In these cases, clinical inertia is a major factor that contributes to inadequate glycaemic control in the long term.

Our results show a global negative effect of T2DM duration on glycaemic control that did not change substantially across the study period. A progressive worsening of mean Hb1Ac values within each sequential evaluation might be expected because the proportion of patients with a disease duration >10 years increased, but this could have been counteracted by an intensified management in all treatment steps, eventually leading to steady mean HbA1c levels along the study. This is a possible explanation if we take into account that patients in the lowest treatment steps (ie, no drugs, and NIADs in monotherapy or combined) and with a disease duration >10 years had lower HbA1c values than those with a disease duration lower than <2 years, as those on poor glycaemic control were probably switched to the next superior treatment step. In contrast, glycaemic control among patients on insulin (alone or in combination) worsened as the duration of disease increased, probably because they are at the last treatment step and only intensive management with multiple insulin doses under endocrinologist supervision may improve control.

This study has strengths and limitations worth mentioning. The main strength is that we used a large outpatient database that, although not completely representative of other areas of Spain, is indicative of the trends of general practitioners' practices in a real-life clinical setting. However, this was a retrospective study subject to errors in data recording. For instance, the percentage of missing values for HbA1c was 35% in 2007 and decreased to 25% in 2013, although this would apply equally to all study periods, therefore not affecting the conclusions of the study. Moreover, we were not able to assess whether the change in prescribed treatments over time was driven by patients' needs and characteristics (eg, prior low tolerability or effectiveness), and we cannot therefore claim a causal effect. Finally, we could not assess whether doses were appropriately chosen, and we did not consider data on prescriptions within the same therapeutic class.

CONCLUSIONS

Although the intensity of pharmacological antidiabetic treatment of T2DM increased substantially during 2007–2013 in Catalonia, there was no evidence that this was accompanied by a positive change in the degree of glycaemic control. This reveals shortcomings in the primary healthcare system that could be tackled through more intensive educational programmes for physicians oriented to the individualisation of glycaemic goals and prioritising more intensive treatments in younger patients.

Author affiliations
[1]DAP-Cat group. Unitat de Suport a la Recerca Barcelona Ciutat, Institut Universitari d'Investigació en Atenció Primària Jordi Gol (IDIAP Jordi Gol), Barcelona, Spain
[2]Centro de Investigación Biomédica en Red de Diabetes y Enfermedades Metabólicas Asociadas (CIBERDEM), Instituto de Salud Carlos III (ISCIII), Spain
[3]Primary Health Care Center La Mina, Gerència d'Àmbit d'Atenció Primària Barcelona Ciutat, Institut Català de la Salut, Sant Adrià de Besòs, Spain
[4]Primary Health Care Center Raval Sud, Gerència d'Àmbit d'Atenció Primària Barcelona Ciutat, Institut Català de la Salut, Barcelona, Spain
[5]Universitat Internacional de Catalunya, Epidemiologia i Salut Pública, Sant Cugat, Spain
[6]Department of Endocrinology & Nutrition, Health Sciences Research Institute & Hospital Universitari Germans Trias i Pujol, Badalona, Spain

Acknowledgements The authors acknowledge Mònica Gratacòs and Amanda Prowse for providing support in manuscript preparation and editing. CIBER of Diabetes and Associated Metabolic Diseases (CIBERDEM) is an initiative from Instituto de Salud Carlos III.

Contributors MM-C and JF-N wrote the manuscript and contributed equally to this study. JR managed the database, performed the statistical analyses and contributed to the discussion. JF-N, MM-C and DM conceived the study, participated in the study design, contributed to data cleaning, analysis and interpretation, reviewed/edited the manuscript and contributed to the discussion. MM-C had full access to all data in the study and takes responsibility for the integrity of data and the accuracy of the data analysis.

Funding This study was funded by Institut Universitari d'Investigació en Atenció Primària Jordi Gol (IDIAP Jordi Gol), and an unrestricted grant provided by Astra Zeneca.

Disclaimer The funding sources had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; or preparation, review or approval of the manuscript.

Competing interests None declared.

Ethics approval Ethics Committee of the Primary Health Care University Research Institute (IDIAP) Jordi Gol.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

REFERENCES

1. International Diabetes Federation. *IDF Diabetes Atlas*. 6th edn. Brussels, Belgium: International Diabetes Federation, 2013.
2. Turner RC, Cull CA, Frighi V, *et al*. Glycemic control with diet, sulfonylurea, metformin, or insulin in patients with type 2 diabetes mellitus: progressive requirement for multiple therapies (UKPDS 49). UK Prospective Diabetes Study (UKPDS) Group. *JAMA* 1999;281:2005–12.
3. Bailey CJ. The current drug treatment landscape for diabetes and perspectives for the future. *Clin Pharmacol Ther* 2015;98:170–84.
4. Holman RR, Paul SK, Bethel MA, *et al*. 10-year follow-up of intensive glucose control in type 2 diabetes. *N Engl J Med* 2008;359:1577–89.
5. Inzucchi SE, Bergenstal RM, Buse JB, *et al*. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care* 2015;38:140–9.
6. Baviera M, Monesi L, Marzona I, *et al*. Trends in drug prescriptions to diabetic patients from 2000 to 2008 in Italy's Lombardy region: a large population-based study. *Diabetes Res Clin Pract* 2011;93:123–30.
7. Chang CH, Jiang YD, Chung CH, *et al*. National trends in anti-diabetic treatment in Taiwan, 2000–2009. *J Formos Med Assoc* 2012;111:617–24.
8. Leal I, Romio SA, Schuemie M, *et al*. Prescribing pattern of glucose lowering drugs in the United Kingdom in the last decade: a focus on the effects of safety warnings about rosiglitazone. *Br J Clin Pharmacol* 2013;75:861–8.

9. Turner LW, Nartey D, Stafford RS, *et al*. Ambulatory treatment of type 2 diabetes in the U.S., 1997–2012. *Diabetes Care* 2014;37:985–92.
10. Strøm H, Selmer R, Birkeland KI, *et al*. No increase in new users of blood glucose-lowering drugs in Norway 2006–2011: a nationwide prescription database study. *BMC Public Health* 2014;14:520.
11. Oishi M, Yamazaki K, Okuguchi F, *et al*. Changes in oral antidiabetic prescriptions and improved glycemic control during the years 2002–2011 in Japan (JDDM32). *J Diabetes Investig* 2014;5:581–7.
12. Hampp C, Borders-Hemphill V, Moeny DG, *et al*. Use of antidiabetic drugs in the U.S., 2003–2012. *Diabetes Care* 2014;37:1367–74.
13. Zaharan NL, Williams D, Bennett K. Prescribing of antidiabetic therapies in Ireland: 10-year trends 2003–2012. *Ir J Med Sci* 2014;183:311–18.
14. Clemens KK, Liu K, Shariff S, *et al*. Secular trends in antihyperglycaemic medication prescriptions in older adults with diabetes and chronic kidney disease: 2004–2013. *Diabetes Obes Metab* 2016;18:607–14.
15. Sharma M, Nazareth I, Petersen I. Trends in incidence, prevalence and prescribing in type 2 diabetes mellitus between 2000 and 2013 in primary care: a retrospective cohort study. *BMJ Open* 2016;6: e010210.
16. Pornet C, Bourdel-Marchasson I, Lecomte P, *et al*. Trends in the quality of care for elderly people with type 2 diabetes: the need for improvements in safety and quality (the 2001 and 2007 ENTRED surveys). *Diabetes Metab* 2011;37:152–61.
17. Mancera-Romero J, Hormigo-Pozo A, Fernández-Arquero J, *et al*. [Use of glucose-lowering drugs in a primary care setting in Malaga during the years 2008–2012]. *Semergen* 2014;40:4–11.
18. Lawrenson R, Williams T, Farmer R. Clinical information for research; the use of general practice databases. *J Public Health Med* 1999;21:299–304.
19. Vinagre I, Mata-Cases M, Hermosilla E, *et al*. Control of glycemia and cardiovascular risk factors in patients with type 2 diabetes in primary care in Catalonia (Spain). *Diabetes Care* 2012;35:774–9.
20. Mata-Cases M, Mauricio D, Vinagre I, *et al*. Treatment of hyperglycaemia in type 2 diabetic patients in a primary care population database in a Mediterranean area (Catalonia, Spain). *J Diabetes Metab* 2014;5:338.
21. Franch-Nadal J, Mata-Cases M, Vinagre I, *et al*. Differences in the cardiometabolic control in type 2 diabetes according to gender and the presence of cardiovascular disease: results from the eControl study. *Int J Endocrinol* 2014;2014:131709.
22. Rodriguez-Poncelas A, Miravet-Jiménez S, Casellas A, *et al*. Prevalence of diabetic retinopathy in individuals with type 2 diabetes who had recorded diabetic retinopathy from retinal photographs in Catalonia (Spain). *Br J Ophthalmol* 2015;99:1628–33.
23. Barrot-de la Puente J, Mata-Cases M, Franch-Nadal J, *et al*. Older type 2 diabetic patients are more likely to achieve glycaemic and cardiovascular risk factors targets than younger patients: analysis of a primary care database. *Int J Clin Pract* 2015;69:1486–95.
24. Mata-Cases M, Casajuana M, Franch-Nadal J, *et al*. Direct medical costs attributable to type 2 diabetes mellitus: a population-based study in Catalonia, Spain. *Eur J Health Econ* 2015. Published Online First: 5 Nov 2015. doi:10.1007/s10198-015-0742-5
25. Ruiz-Tamayo I, Franch-Nadal J, Mata-Cases M, *et al*. Noninsulin antidiabetic drugs for patients with type 2 diabetes mellitus: are we respecting their contraindications? *J Diabetes Res* 2016;2016:7502489.
26. Mata-Cases M, Mauricio D, Franch-Nadal J. Clinical characteristics of type 2 diabetic patients on basal insulin therapy with adequate fasting glucose control that do not achieve glycated hemoglobin targets. *J Diabetes* 2016. Published Online First: 8 Jan 2016. doi:10.1111/1753-0407.12373.
27. Goberna R, Aguilar-Diosdado M, Santos-Rey K, *et al*. Consensus document for the harmonization of HbA1c results in Spain. *Av Diabetol* 2009;25:35–7.
28. Mata-Cases M, Cos-Claramunt FX, Morros R, *et al*. Abordatge de la diabetis mellitus tipus 2 [online]. 2010; Guies de pràctica clínica, num 15. http://www.gencat.cat/ics/professionals/guies/diabetis/diabetis.htm (accessed 27 Jun 2014).
29. Avilés F, MB L, Coma Redon E, *et al*. Sistema de Información de los Servicios de Atención Primaria (SISAP). La experiencia 2006-2009 del Institut Català de la Salut (ICS). *RISAI* 2010;2:1–17.
30. Alemán JJ, Artola S, Franch J, *et al*. Recomendaciones para el tratamiento de la diabetes mellitus tipo 2: control glucémico. *Diabetes Práctica* 2014;5:1–48.
31. Clemens KK, Shariff S, Liu K, *et al*. Trends in antihyperglycemic medication prescriptions and hypoglycemia in older adults: 2002–2013. *PLoS ONE* 2015;10:e0137596.
32. Rafaniello C, Arcoraci V, Ferrajolo C, *et al*. Trends in the prescription of antidiabetic medications from 2009 to 2012 in a general practice of Southern Italy: a population-based study. *Diabetes Res Clin Pract* 2015;108:157–63.
33. Kohro T, Yamazaki T, Sato H, *et al*. Trends in antidiabetic prescription patterns in Japan from 2005 to 2011. *Int Heart J* 2013;54:93–7.
34. Sinclair AJ, Paolisso G, Castro M, *et al*., European Diabetes Working Party for Older People. European Diabetes Working Party for Older People 2011 clinical guidelines for type 2 diabetes mellitus. Executive summary. *Diabetes Metab* 2011;37(Suppl 3):S27–38.
35. NICE (National Institute for Health and Clinical Excellence). Clinical guideline CG87. Type 2 diabetes: the management of type 2 diabetes. Last updated December 2014. http://guidance.nice.org.uk/CG87/NiceGuidance/pdf/English
36. Nissen SE, Wolski K. Effect of rosiglitazone on the risk of myocardial infarction and death from cardiovascular causes. *N Engl J Med* 2007;356:2457–71.
37. Swinnen SG, Hoekstra JB, DeVries JH. Insulin therapy for type 2 diabetes. *Diabetes Care* 2009;32(Suppl 2):S253–9.
38. Lewis JD, Ferrara A, Peng T, *et al*. Risk of bladder cancer among diabetic patients treated with pioglitazone: interim report of a longitudinal cohort study. *Diabetes Care* 2011;34:916–22.
39. Ryder RE. Pioglitazone has a dubious bladder cancer risk but an undoubted cardiovascular benefit. *Diabet Med* 2015;32:305–13.
40. Karagiannis T, Paschos P, Paletas K, *et al*. Dipeptidyl peptidase-4 inhibitors for treatment of type 2 diabetes mellitus in the clinical setting: systematic review and meta-analysis. *BMJ* 2012;344:e1369.
41. Mata-Cases M, Benito-Badorrey B, Roura-Olmeda P, *et al*. Clinical inertia in the treatment of hyperglycemia in type 2 diabetes patients in primary care. *Curr Med Res Opin* 2013;29:1495–502.
42. Alonso-Morán E, Orueta JF, Esteban JIF, *et al*. Prevalence and quality of care indicators of type 2 diabetes in the population of the Basque Country (Spain). *Av Diabetol* 2015;31:72–9.
43. Subramanian S, Hirsch IB. Personalized diabetes management: moving from algorithmic to individualized therapy. *Diabetes Spectr* 2014;27:87–91.
44. Khunti K, Wolden ML, Thorsted BL, *et al*. Clinical inertia in people with type 2 diabetes: a retrospective cohort study of more than 80,000 people. *Diabetes Care* 2013;36:3411–17.
45. Khunti K, Nikolajsen A, Thorsted BL, *et al*. Clinical inertia with regard to intensifying therapy in people with type 2 diabetes treated with basal insulin. *Diabetes Obes Metab* 2016;18:401–9.

5. Discusión conjunta de los artículos

A continuación, vamos a comentar los principales hallazgos descritos en las publicaciones de esta tesis, complementadas con algunos datos provenientes de otras publicaciones relacionadas, que nos permitirán conocer más a fondo la evolución de la atención a la DM2 en atención primaria durante dos décadas.

En primer lugar, debemos recordar que la evaluación de la atención a la DM2 en nuestro país ha tenido dos fases importantes en función de cómo se ha obtenido la información. En el primer periodo, que comprende desde 1993 a 2007, se basa en la recogida de datos de forma manual a partir de una pequeña muestra, sistemática o aleatoria, de las historias clínicas de papel de cada centro de salud participante en el programa de la red MCC-GEDAPS [44]. En el segundo período, la informatización de todos los centros de salud ha permitido que se pueda disponer de los datos clínicos de todas las personas con DM2 atendidas por el ICS entre 2007 y 2013, y que han sido publicados más recientemente [59]. A partir de los datos SIDIAP se han podido estimar también gran parte de los indicadores GEDAPS, con algunas matizaciones y limitaciones que comentaremos más adelante.

5.1. Evolución de la prevalencia de diabetes registrada

Lo primero que destaca es el incremento tan importante de la prevalencia de DM2 que se produjo entre 1993 y 2007 y posteriormente entre 2007 y 2013 (tabla 1). En el periodo GEDAPS pasó del 3,2% en 1993 al 5,4% en 2007, por tanto, un incremento del 69%. Sin embargo, en los datos SIDIAP de 2007 fue sólo del 4%, y posteriormente ha ido aumentando progresivamente hasta alcanzar el 5,5% en 2013, con un incremento del 37,5%. Estos valores son en población mayor de 14 años, pero si lo calculamos en población mayor de 18 años, que es el criterio que se suele utilizar en los estudios epidemiológicos el valor de 2013 es de 7,4%, que es muy similar al 7,8% observado en el estudio Di@bet.es [2].

Finalmente, aunque no se puede descartar un aumento real de la prevalencia por una actitud más proactiva de los profesionales en la detección de casos asintomáticos en pacientes de riesgo, creemos que el incremento observado en el último período es fundamentalmente atribuible a la mejora en el registro pues el valor de 2013 [59] se ha equiparado al observado en la evaluación GEDAPS de 2007 [44].

Tabla 1: Evolución de los principales indicadores de proceso. Evaluaciones GEDAPS 1993-2007 [44] y SIDIAP 2009-2013 [59]

	GEDAPS						SIDIAP		
	1993	1995	1998	2000	2002	2007	2009	2011	2013
N	2.239	3.532	4.217	4.567	5.819	3.130	286.019	317.215	343.969
Prevalencia (%)[1]	3,2	4,2	4,9	5,2	5,4	5,4	4,5	5,0	5,5
Exploraciones (%)									
IMC	77,6	78,6	81	77,8	78,8	82,2	64	64,9	66,3
Presión arterial	94,5	93	93,9	92	92,2	92,3	79,9	81,4	83,4
Fondo de ojo o retinografía	52,2	48,4	52,6	52,2	54,3	49,0	69[2,3]	74[2,3]	75[2,3]
Revisión de los pies	48,9	58,3	54,3	54,1	56,6	64,2	57[2]	64[2]	65[2]
Pruebas de laboratorio (%)									
HbA1c anual	51,7	70,2	77,6	82,8	85,3	88,9	67,6	71,4	74,3
HbA1c 2 veces/año	30,0	41,1	40,6	42,2	55,5	40,4	-	-	-
Colesterol total	75,9	80,5	83,1	84,4	86,5	90,9	71,7	74,4	75,5
Albuminuria	33,9	49,0	62,5	68,7	72,8	59,4	32,2	37,9	37,9

1. Prevalencia de DM2 registrada en población mayor de 14 años
2. Datos de la Central de Resultats. Observatori del Sistema de Salut de Catalunya. AQUAS [83]
3. Exploración en los dos últimos años. Incluye únicamente pacientes menores de 75 años

5.2. Evolución de los indicadores de proceso

Los resultados de las evaluaciones GEDAPS han permitido conocer la evolución de los indicadores de proceso y resultados durante un periodo de 15 años. En 2012 se publicaron los resultados comparativos de todas las evaluaciones, desde 1993 a 2007 [44], que previamente habían sido presentados en diferentes jornadas y congresos nacionales e internacionales.

En la Tabla 1 se pueden ver los resultados de los principales indicadores de proceso del primer periodo (GEDAPS, 1993-2007) junto a los del segundo período (SIDIAP, 2009- 2013. Se trata de un resumen de los datos publicados en 2012 [44] y 2016 [59], y de algunos otros provenientes de dichas evaluaciones, aunque no aparecen explícitamente en dichas publicaciones. Para facilitar su visualización y homogeneizar los intervalos temporales, los datos del SIDIAP se muestran cada 2 años y en el caso del 2007 hemos optado por incluir los datos de GEDAPS ya que, aunque se trata de una muestra, provienen de la revisión manual de los registros informáticos de cada paciente.

En primer lugar, se puede ver cómo en el período GEDAPS las determinaciones de presión arterial e IMC se mantuvieron constantes y con un cumplimiento superior al 80%. En cambio, las determinaciones de laboratorio mejoraron notablemente: por ejemplo, en el año 1993 sólo la mitad de las personas con diabetes tenían una determinación anual de la HbA1c que mejoró de manera progresiva llegando a valores de casi el 90% en 2007. En cambio, destaca que el porcentaje de pacientes con dos determinaciones de HbA1c al año, que inicialmente se incrementó notablemente, llegó a un máximo del 55% en 2002 y luego descendió al 40% en 2007. Sorprende que a pesar de las recomendaciones de todas las guías de tomar decisiones cada 3 o 6 meses, muchas analíticas se realizaran solo una vez al año, quizás porque se hubiera establecido la rutina de la analítica anual en pacientes con un control previo aceptable. No disponemos de este indicador en las evaluaciones SIDIAP, aunque cabe esperar un resultado similar o incluso inferior pues la media de determinaciones de Hba1c en un período de 5 años (entre 2010 y 2014) en pacientes con control deficiente tratados con dos o más antidiabéticos no

insulínicos en la base de datos SIDIAP fue de 7 (datos SIDIAP, pendientes de publicación).

El cribado anual de la microalbuminuria en orina matinal también se dobló pasando del 34% de pacientes en 1993 al 73% en 2002, aunque luego descendió al 59% en 2007. Este empeoramiento estuvo probablemente relacionado con la informatización de las peticiones de laboratorio el año anterior, en que se dejó de incluir este parámetro en la petición electrónica del protocolo anual de diabetes, realizando únicamente el sedimento, lo que sin duda pasó inadvertido a bastantes profesionales durante el primer año. Este cribado se mantiene en la actualidad como un protocolo independiente (cribado de albuminuria, mediante la determinación del cociente albúmina/creatinina) y explicaría en parte la ausencia de mejora, pero no toda, ya que también depende de que el profesional no se olvide de entregar el bote de orina al paciente y que éste finalmente se acuerde de traer la muestra el día del análisis.

En cuanto a la revisión anual de los pies, hubo un incremento inicial considerable pasando del 49% en 1993 al 58% en 1995, y posteriormente se han mantenido más o menos estable hasta llegar al 64% en 2007, probablemente relacionado con una mejora del registro por la generalización de los registros informáticos en los años previos y a su inclusión como indicador de calidad para los incentivos económicos del ICS [84]. Posteriormente, se ha mantenido entre el 57 y 65% en las evaluaciones SIDIAP y constituye una tasa de cribado similar descrita en un estudio multicéntrico en el estado español observando una gran variabilidad entre centros[85]. Es difícil valorar realmente el motivo de que no mejore mucho más este indicador, ya que depende únicamente de los profesionales de atención primaria, principalmente de enfermería y está incentivado en los indicadores de calidad del Estàndar de Qualitat Assistencial (EQA) del ICS desde la informatización de la historia clínica (e-CAP) [84]. Probablemente está relacionado con el hecho de que es una intervención que supone un tiempo adicional en la consulta, y la competencia entre demandas juega en contra de esta actividad preventiva que puede ser olvidada o pospuesta y que además no es una necesidad percibida por los pacientes [86–89].

En lo que respecta a la realización del fondo de ojo por el oftalmólogo, que era el método de cribado de retinopatía diabética anterior a la generalización de la retinografía con cámara no midriática, se mantuvo estable durante todo el periodo GEDAPS, alrededor del 50%, con una subida posterior de hasta el 75% en 2013 (SIDIAP). Se debe tener en cuenta que durante el período GEDAPS; el cribado dependía de otro profesional (oftalmólogo) y los resultados frecuentemente no eran registrados o informados por escrito a los profesionales de atención primaria. Además, en los pacientes sin retinopatía previa y control glucémico aceptable se considera correcto retrasar a dos años su realización [90,91,92] y así de hecho a finales de los años 90 en numerosas áreas de Catalunya se amplió el periodo de realización de la revisión a dos años en los pacientes con retinopatía no proliferativa leve y tres años en los pacientes con cribado negativo previo[60]. Teniendo en cuenta esta realidad, en la última evaluación GEDAPS de 2007 se recogieron los datos del cribado de los dos años anteriores, resultando que un 49% de pacientes disponía del cribado realizado el mismo año y que el porcentaje se elevaba al 64% teniendo en cuenta además las del año previo (datos no publicados, disponibles en la web redgdps.org). Además, se debe tener en cuenta que la generalización de los programas de cribado de retinopatía diabética mediante retinografía no midriática y la incorporación automática de sus resultados en la historia clínica informatizada, es posterior a las evaluaciones GEDAPS, lo que explicaría la importante mejora en este indicador entre 2009 y 2013. Finalmente recordar que el cribado está también incluido en los indicadores de calidad EQA [84].

En conjunto, los resultados en los indicadores de proceso traducen una progresiva implicación de los profesionales de primaria en el manejo de la enfermedad, pero también las dificultades relacionadas con los sistemas de registro, la retroalimentación de la información desde otros niveles asistenciales y las propias limitaciones organizativas y de presión asistencial en muchos centros. El esfuerzo ha sido considerable y los resultados son incluso superiores a los observados en otros países o comunidades autónomas de España. En los datos disponibles provenientes de auditorías en atención primaria, la mayoría de indicadores muestran importantes déficits, por lo que en

algunos países se han desarrollado estrategias denominadas *shared care* (cuidados compartidos multidisciplinares) en que el paciente es derivado anualmente para practicar una revisión completa anual por parte de un equipo especializado (Unidad de Diabetes) [73,82,93–95] o a una consulta especializada de enfermeras específicamente formadas y con programas informáticos de ayuda en la toma de decisiones [96–102].

En nuestro país y concretamente en el ICS, desde hace ya más de una década, se dispone de su sistema de recordatorios automatizados al entrar en la historia clínica de los pacientes que no cumplen el objetivo o que no disponen de la prueba o exploración en el último año (por ejemplo, Presión arterial, HbA1c, retinografía o ECG) [84,103]. Además el profesional puede visualizar o imprimir listados de estos pacientes e incluso , desde hace tres años se dispone de una herramienta específica que permite hacer búsquedas selectivas en función de determinadas características clínicas de los pacientes, diagnósticos o tipos de tratamiento [103]. Todo ello son herramientas que, aunque no garantizan que se realicen todas las actividades de proceso en todos los pacientes, han permitido mejorar notablemente la atención a la DM2. Obviamente siempre habrá pacientes que se controlan en otros niveles asistenciales o en la medicina privada, que no acudirán a las revisiones o que al visitarse por otros motivos más prioritarios quedarán sin beneficiarse de las intervenciones preventivas relacionadas con la diabetes.

5.3. Evolución de los indicadores de resultados

En la tabla 2 se puede ver la evolución de las características de los pacientes y los indicadores del programa de MCC-GEDAPS, tanto los de resultados intermedios (valores de HbA1c, presión arterial, colesterol, índice de masa corporal -IMC-, tabaquismo) como los de resultados finales (presencia de complicaciones). También se incluye el escalón terapéutico del tratamiento antidiabético, que, aunque habitualmente se considera un indicador de proceso se haya muy relacionado con las características de los pacientes y el grado de control.

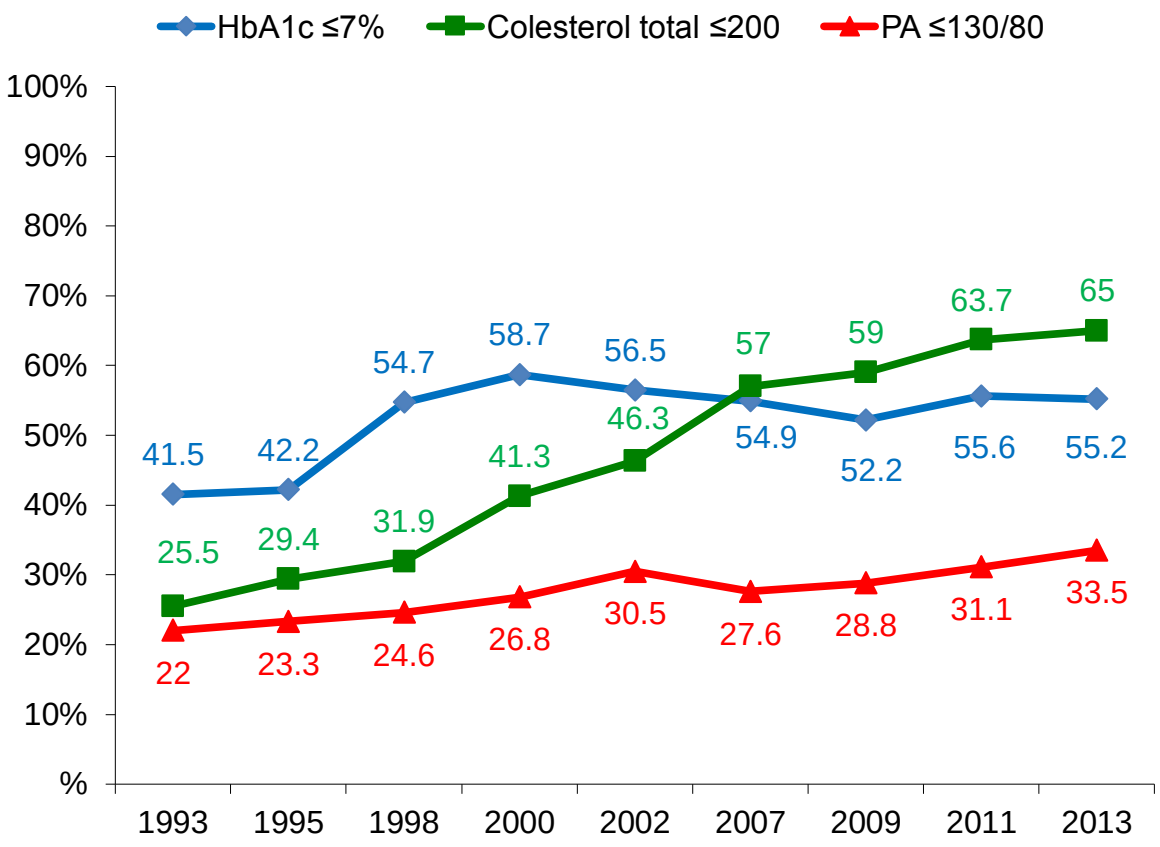
En las figuras 1 y 2 se puede ver de manera más gráfica la evolución del grado de control glucémico, lipídico y de presión arterial. En cuanto a los datos de 2007, a pesar de disponer también de los datos GEDAPS, hemos incluido en la tabla 2 y las figuras 1 y 2 únicamente las de la evaluación del SIDIAP ya que incluyen toda la población y no solo una muestra. Más adelante, en la tabla 3, se muestran los principales resultados de ambas evaluaciones de 2007, GEDAPS y SIDIAP, con el fin de compararlas y analizar las fortalezas y limitaciones metodológicas de cada una de ellas. En los siguientes apartados se analizarán por separado la evolución de la prevalencia de la DM2, el grado de control glucémico y de los factores de riesgo cardiovascular teniendo en cuenta diferentes subgrupos de población y finalmente las características del tratamiento antidiabético.

Tabla 2: Características clínicas y principales indicadores de resultados. Los valores corresponden a las evaluaciones GEDAPS 1993 a 2002 [44] y las del SIDIAP de 2007 a 2013 [59].

	GEDAPS					SIDIAP			
Año	1993	1995	1998	2000	2002	2007	2009	2011	2013
N	2.239	3.532	4.217	4.567	5.819	257.072	286.019	317.215	343.969
Características de los pacientes									
Edad (años, media)	67,1	66,3	67,2	67,1	67,3	67,7	68,1	68,4	68,9
Varones (%)	43,4	45,5	47,1	47,9	48,2	52,2	53,2	53,9	54,3
Duración de la DM2 (años, media)	7,4	7,3	7,5	7,6	8,1	5,4	6,3	7,0	7,8
IMC>30 kg/m^2 (%)	37	37	39,2	40,5	42,6	45,6	45,4	45,3	45,1
HbA1c (%, media)[1]	7,7	7,6	7,1	7	7,1	7,16	7,25	7,2	7,24
Presión arterial (mmHg, media)	144/81	143/81	142/81	139/81	138/79	138/77	137/76	136/76	135/75
Colesterol total (mg/dl, media)	228	225	222	211	207	195	193	189	187
Fumadores (%)	13,4	14,3	15,0	14,4	15,4	16,7	16,2	13,8	13,4
Exfumadores	-	-	-	-	-	18,8	20,3	22,7	25,1
Tratamiento de la hiperglucemia (%)									
No farmacológico	25,7	27,7	29,4	27,9	25,4	28,1	24,5	20,4	19,4
Antidiabéticos no insulínicos	52,2	50	49,9	51,7	54,6	54,5	57,5	60,9	60,6
Insulina	22,1	22,2	20,6	20,4	19,9	17,5	18	18,7	20
Prevalencia de complicaciones crónicas (%)									
Retinopatía	18,8	14,5	13,5	10,3	9,8	4,6	5,7	6,8	7,6
Albuminuria[2]	18,5	17,4	17,6	15,6	16,7	18,7	18,7	18,9	20
Cardiopatía isquémica	12,9	12,0	12,5	11,2	12,5	11,4	12,1	12,6	13
Accidente Vascular Cerebral	6,8	6,8	6,6	5,9	5,7	6,6	7,2	7,8	8,4
Arteriopatía periférica	-	-	-	-	-	2,6	3,3	4,2	4,9
Pie diabético (úlceras+amputaciones)	9,5	7,0	4,2	3,5	3,0	-	-	-	-
Insuficiencia cardiaca	-	-	-	-	-	4,1	4,6	5,3	6,2

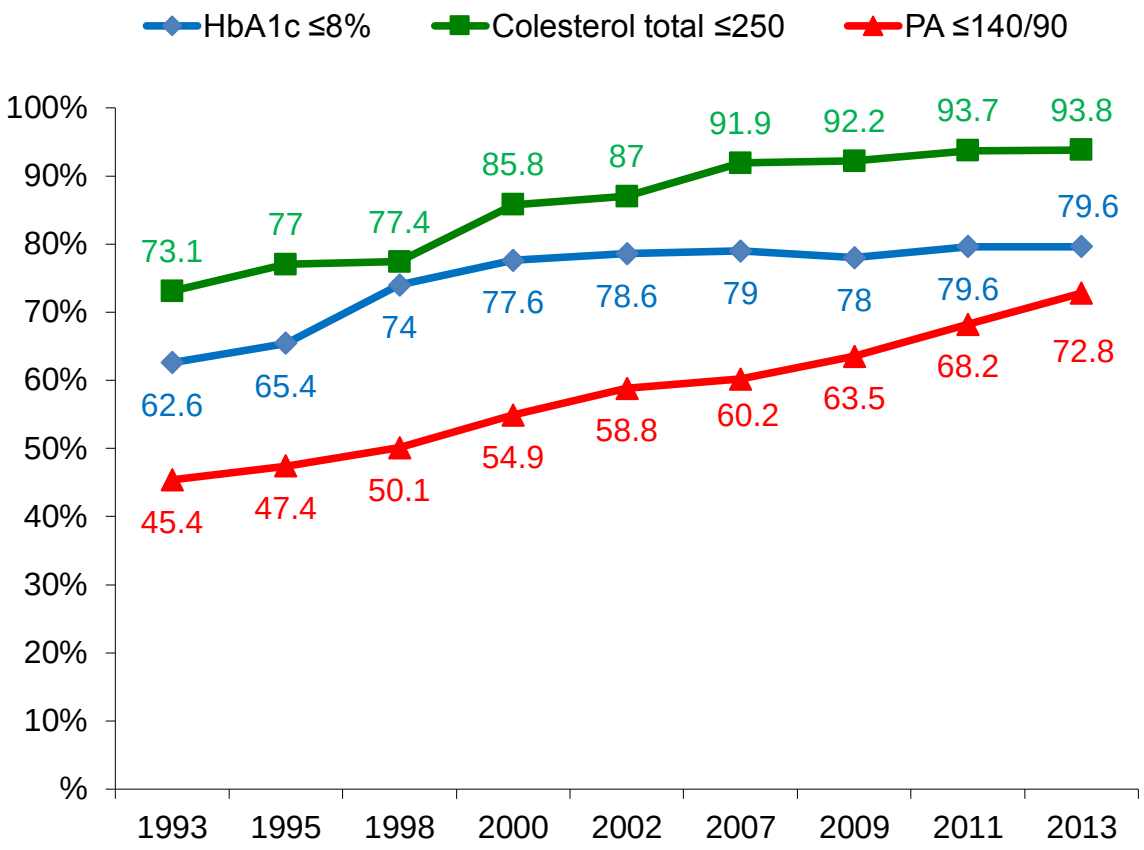
1. En Cataluña, la determinación de la HbA1c se estandarizó al método DCCT el 1 de enero de 2010. En las evaluaciones previas a este periodo en la mayor parte de laboratorios se utilizaba el método japonés (JDS / JSCC), que proporcionaba valores inferiores (-0,4%) a los del método DCCT. Los datos posteriores a 2010 ya son todos con valores DCCT (normalidad 4-6%).
2. Incluye microalbuminuria y macroalbuminuria

Figura 1. Evolución del control de los factores de riesgo cardiovascular en Catalunya con criterios estrictos según los indicadores definidos por el grupo GEDAPS. Los datos corresponden a las evaluaciones GEDAPS 1993 a 2002 [44] y las del SIDIAP de 2007 a 2013 [59].



PA: Presión arterial

Figura 2. Evolución del control de los factores de riesgo cardiovascular en Catalunya con criterios menos estrictos según los indicadores definidos por el grupo GEDAPS. Los datos corresponden a las evaluaciones GEDAPS 1993 a 2002 [44] y las del SIDIAP de 2007 a 2013 [59].



PA: Presión arterial

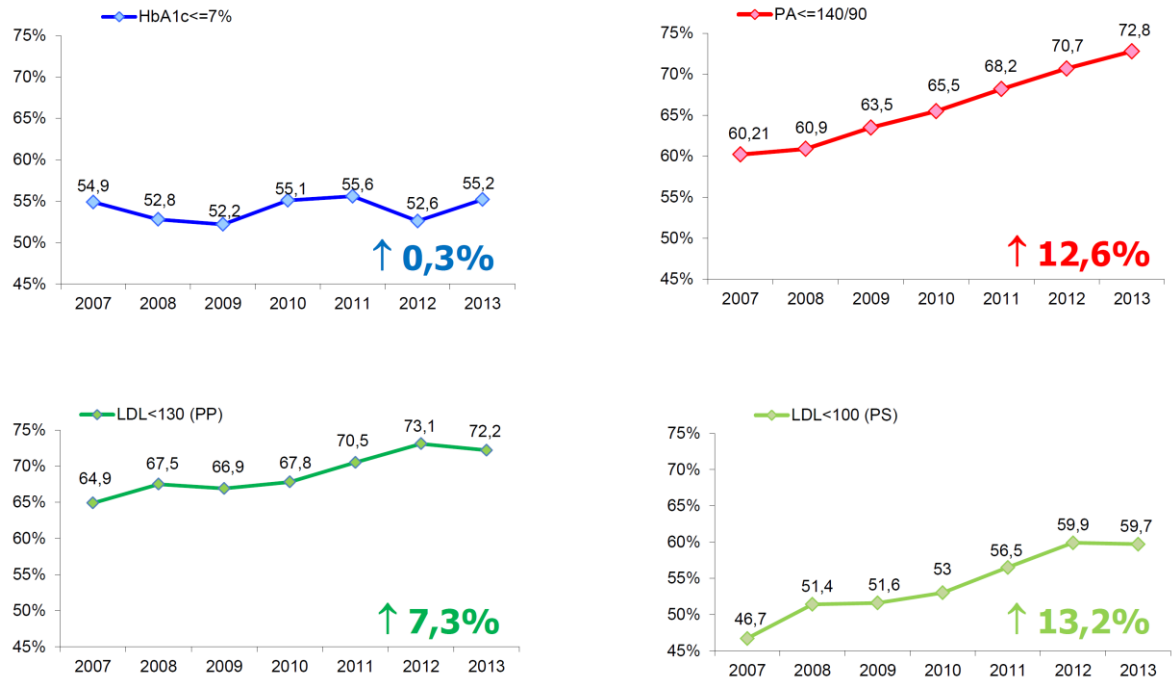
5.4. Evolución del control glucémico y de los factores de riesgo cardiovascular

Como se ve en las figuras 1 y 2, la mejora en el grado de control glucémico ha sido progresiva en el primer período (años 90): el 41% tenían una HbA1c ≤ 7% en 1993 y subió hasta el 59% en 2000) (figura 1) y pasó del 63% al 79% con el criterio de HbA1c ≤ 8% en el mismo período (figura 2). En cambio, se ha mantenido bastante estable a partir de 2002, alrededor del 55% con HbA1c ≤ 7% y con unas medias alrededor del 7,2%, lo que probablemente está relacionado con que el umbral de valoración de la calidad de la atención (EQA) y la consecución de los incentivos económicos de la Dirección por Objetivos del ICS está fijado en el 8%[84], valor que alcanzan prácticamente el 80% de los pacientes y sin apenas cambios desde 2007 (figuras 2 y 3). Además, existe una gran presión por parte de la institución en contra de la prescripción de fármacos antidiabéticos de reciente introducción, que están penalizados [104], tanto por razones de seguridad como de tipo económico. El hecho de que únicamente estén incentivados metformina y sulfonilureas, seguramente contribuye a que, en pacientes que ya están recibiendo estos dos fármacos, no se intensifique el tratamiento (inercia terapéutica) cuando el siguiente escalón es la insulinización [50,105–111]. Finalmente no debe olvidarse que para conseguir un buen control es preciso de la participación y compromiso del paciente: en muchos casos la inercia clínica es en realidad la respuesta a una baja adherencia [106,112–117]. Cuando se detecta una baja adherencia nos vemos obligados a dar una nueva oportunidad al paciente lo que supone a veces posponer cambios terapéuticos que probablemente serán inevitables tarde o temprano. El retraso en la intensificación se ha asociado con un incremento de las complicaciones y los costes derivados de las mismas [109–111,118].

En cambio, los valores de PA y colesterol han seguido mejorando progresivamente, tanto en los criterios de control estricto como menos estricto (figuras 1 y 2). En las evaluaciones SIDIAP también se dispone de los valores de colesterol-LDL (figura 3), cuyos objetivos son diferentes en prevención primaria (<130 mg/dl) y en secundaria (<100 mg/dl) [34,35]. También en ambos casos se observa mejoría, aunque mayor, y clínicamente más relevante, en los

pacientes en prevención secundaria. Seguramente es un reflejo de que los criterios de control para la incentivación económica del ICS sean comparativamente más estrictos en el caso de la PA (<130/80 mmHg hasta 2007 y posteriormente <140/90 mmHg) y del colesterol-LDL (<100 mg/dl en prevención secundaria y <130 mg/dl en prevención primaria) que el de la HbA1c<8% del control glucémico [84] (figura 3). También ha influido que se partía de valores mucho más bajos y a que existe un consenso generalizado e indiscutible sobre los beneficios del control estricto de la presión y el colesterol en el paciente con diabetes, lo que seguramente ha contribuido a que estos indicadores hayan continuado mejorando de manera progresiva.

Figura 3. Evolución del grado de control de los Factores de Riesgo Cardiovascular en las evaluaciones SIDIAP 2007 a 2013 [59].



PP: pacientes en prevención primaria (sin enfermedad cardiovascular)

PS: pacientes en prevención secundaria (con enfermedad cardiovascular)

En lo que se refiere a la prevalencia del tabaquismo se ha observado una tendencia a su disminución (tabla 2). Inicialmente, en 1993, era del 13,4% y fue aumentando progresivamente durante las evaluaciones GEDAPS, de manera

similar al aumento de la proporción de varones en las muestras. La mayor prevalencia se constató en la evaluación SIDIAP de 2007, que fue del 16,7%. Posteriormente, y a pesar de seguir aumentando la presencia de varones, se ha ido reduciendo paulatinamente hasta llegar al 13,4% en 2013 (tabla 2), atribuible a la mayor proporción de pacientes que abandonan el hábito. En el período SIDIAP se dispone de información sobre el porcentaje de exfumadores, que pasó del 18,8% en 2007 al 25,1% en 2013, lo que explicaría la mejora en este factor de riesgo cardiovascular tan relevante.

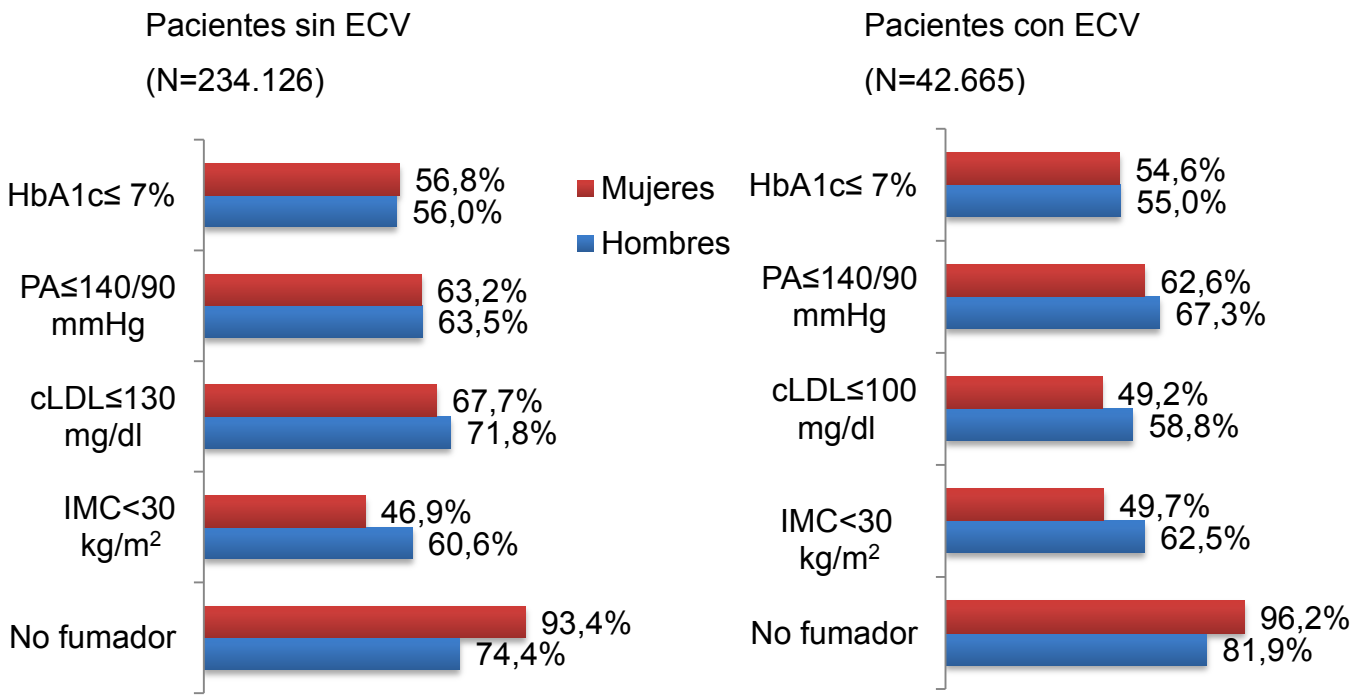
En cuanto a la prevalencia de la obesidad, se debe destacar el importante incremento que se observó entre 1993 y 2007 (del 37% a 50%), que pudo ser reflejo de la progresiva detección y registro de diabetes en pacientes asintomáticos y menos frecuentadores, en general más obesos y probablemente en fases más iniciales de la enfermedad, o bien por un incremento real de la prevalencia de obesidad en este grupo de edad de la población. Así, la prevalencia de la obesidad en la población adulta española prácticamente se duplicó en los 14 años transcurridos entre 1987 y 2001(del 8 al 16%)[119], aunque posteriormente parece que se han estabilizado entre 2010 y 2015 en la encuesta nacional de población española en población entre 18 y 64 años [120]. También en el Reino Unido, en un período similar, la prevalencia de obesidad en la población general pasó del 13 al 24% en varones y del 16 al 25% en mujeres entre 1993 y 2012, siendo el mayor incremento entre los años 1993 a 2003 y disminuyendo la pendiente de crecimiento en los años posteriores [121].

En los datos SIDIAP de 2007 a 2013 la prevalencia de obesidad se ha mantenido estable alrededor del 45%, sin que haya habido cambios relevantes en la edad o proporción de varones y mujeres. Como es sabido en los estudios poblacionales y también en los estudios basados en el SIDIAP, la prevalencia de obesidad es más alta en las mujeres y disminuye progresivamente en ambos sexos en pacientes de edad avanzada.

Finalmente, hay que resaltar que existen diferencias de género en cuanto al control de los factores de riesgo. Así, las mujeres con DM2, aparte de ser más obesas, tienen un peor control de la presión arterial y del colesterol-LDL, tanto en prevención primaria como secundaria, tal como se vio al analizar por género los resultados de 2009 (figura 4)[57]. Debemos señalar que el porcentaje de

pacientes en tratamiento antihipertensivo o hipolipemiante son similares [57], por lo que cabe pensar que el tratamiento es menos intenso (menores dosis de estatinas, por ejemplo) o una mayor dificultad en conseguir los objetivos por otras razones que desconocemos. En cambio, las mujeres son menos fumadoras. Finalmente, no hubo diferencias significativas por género en cuanto al control glucémico [57].

Figura 4. Porcentaje de pacientes con buen control de los factores de riesgo cardiovascular por género y presencia de enfermedad cardiovascular. Datos SIDIAP de 2009 [57]

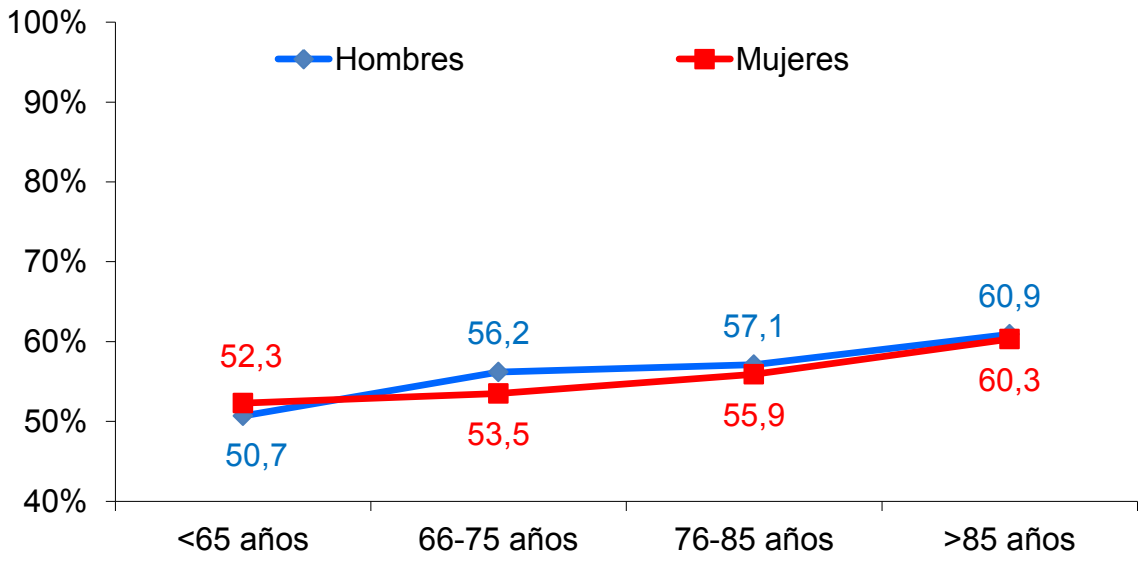


ECV: Enfermedad Cardiovascular

5.5. Control glucémico en subgrupos de pacientes y según duración de la diabetes

En cuanto al control glucémico, en general, tanto en las evaluaciones GEDAPS como en las del SIDIAP, no hay grandes diferencias por género (figura 5) o por presencia de obesidad o complicaciones cardiovasculares (figura 4), pero sí por la edad: el control es peor en los grupos de edad más jóvenes (menores de 65 años) y va mejorando conforme avanza la edad de los pacientes (figura 5) [58].

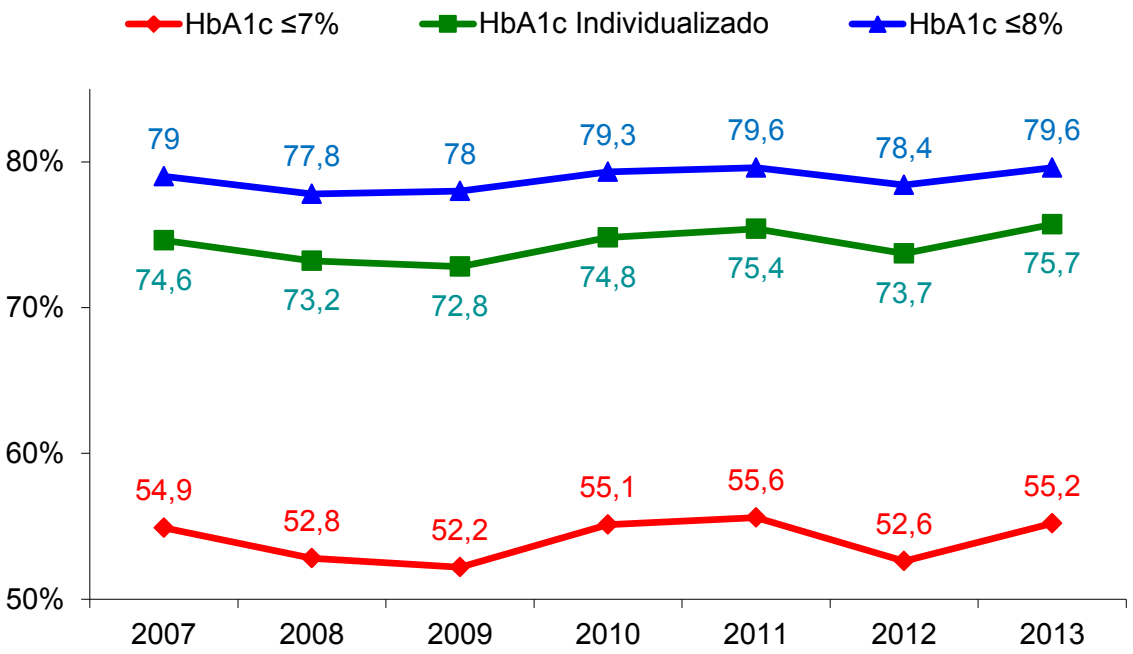
Figura 5. Porcentaje de pacientes con buen control glucémico (HbA1c≤7%) según grupos de edad y sexo. Datos SIDIAP de 2011[58]



Este fenómeno ha sido observado en numerosos estudios y en parte puede ser debido a la mayor prevalencia de obesidad en los más jóvenes [58,79,80] y a que, en éstos, la adherencia es menor que en la población de edad avanzada. Este último aspecto no ha sido valorado específicamente en estas evaluaciones, pero ha sido descrito en diferentes estudios y revisiones narrativas [112,116,117,122]. También podría estar relacionado con el fenómeno del sesgo de supervivencia, en el que los pacientes más saludables llegarían a fases más avanzadas de la vida [123], pero también por el aumento de la incidencia de la DM2 en pacientes

de edad avanzada [124]. La prevalencia en los mayores de 75 años, llega a ser de un 37,4% en nuestro país, aunque solo conocida (diagnosticada previamente) en el 20,7% [2]. Además, es sabido que la diabetes de inicio en el anciano, por su menor esperanza de vida, no tiene apenas impacto en su supervivencia, pues se requieren bastantes años de exposición a la hiperglucemia para que se manifiesten las complicaciones de la enfermedad [2,58,113,123–126]. En estos pacientes la prioridad debe ser conseguir la máxima calidad de vida posible más que perseguir la normoglucemia y, sobre todo, evitar el sobretratamiento ya que la hipoglucemia es una complicación temible en estos pacientes [123,127–129].

Figura 6. Grado de control glucémico según diferentes criterios: general (≤7%), Institut Català de la Salut (≤8%) y el individualizado según la propuesta RedGDPS 2014 [41] en las evaluaciones SIDIAP 2007-2013 [59]



Los objetivos de control individualizados (figura 6), basado en las recientes recomendaciones de la RedGDPS [41], se consiguen más fácilmente en pacientes de edad avanzada que en los pacientes más jóvenes [58]. Sin embargo, son éstos los que realmente más se beneficiarían de las

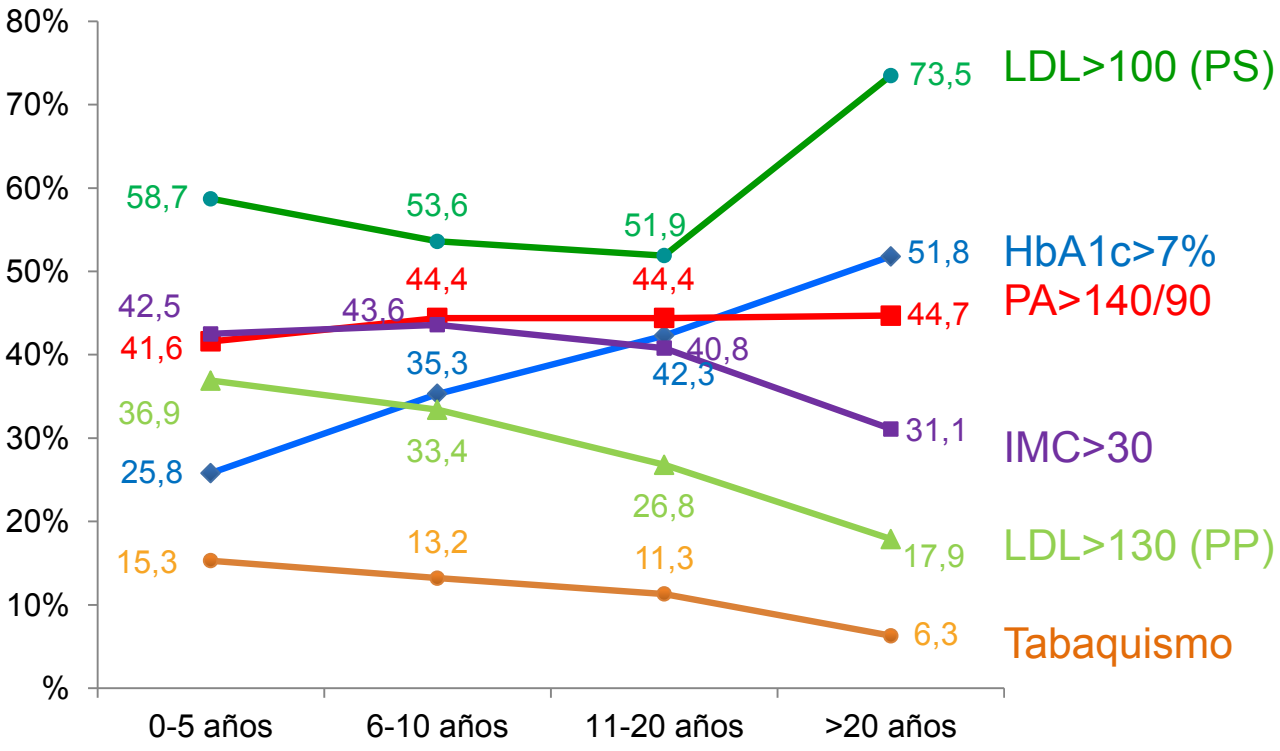
intervenciones terapéuticas a largo plazo, sobre todo al inicio de la enfermedad como se desprende de los resultados del estudio United Kingdom Prospective Diabetes Study (UKPDS), que incluyó únicamente pacientes menores de 65 años, de reciente diagnóstico y sin complicaciones cardiovasculares [21,130]. Por otra parte, el umbral del 8% para la incentivación económica de los profesionales por parte de la institución [84] (figura 6) y la existencia de restricciones para el uso de nuevos fármacos que no sean metformina o sulfonilureas (penalización con incentivación negativa) [104,131] pueden haber contribuido a la falta de intensificación en el grupo de pacientes más jóvenes, y por tanto a la ausencia de mejora del control glucémico durante este período [59]. Así por ejemplo solo un 51% de los menores de 65 años sin complicaciones consiguieron el objetivo individualizado de HbA1c≤7% [41], mientras que el objetivo específico para los mayores de 75 años (<8,5%) se consiguió en más del 90% de casos [59].

Dicho esto, debemos hacer notar que el 1 de enero de 2010 se produjo en España la homogeneización de los resultados de la HbA1c, que en la mitad de laboratorios hasta entonces se efectuaban por el método japonés (calibración JDS/JSCC; normalidad= 3,9-5,7%) [132], y pasaron a ser todos estandarizados al método norteamericano (calibración NGSP/DCCT; normalidad= 4-6%) [133], lo que pudo implicar un incremento de hasta casi medio punto en los valores medios de Hba1c en alrededor de la mitad de los pacientes. Así, por ejemplo, en el caso de la evaluación de SIDIAP 2009 (antes de la estandarización), los valores de Hba1c sin ajustar fueron de 6,85%, mientras que una vez convertidos a DCCT para su publicación en Diabetes Care, el valor resultante final fue de 7,15%, por tanto un incremento de 0,3 puntos [53]. En el mismo año 2007, en la evaluación GEDAPS, la media de HbA1c sin estandarizar fue también de 6,8% [44], lo que una vez más confirma la validez externa de los datos de las evaluaciones del GEDAPS. En la extracción de datos del SIDIAP 2007-2013 la media de 2010 fue del 7,19%, sin que se observara el incremento esperable de la HbA1c, sin embargo se acompañó de un incremento del porcentaje de pacientes de todos los escalones de tratamiento farmacológico y una disminución de los tratados solo con dieta y ejercicio de un 2% [59], lo que hace suponer que la subida de HbA1c pudo ser compensada a lo largo del año

con una intensificación del tratamiento farmacológico, llegando a mejorar incluso el porcentaje de pacientes que conseguían objetivos respecto del año anterior pasando del 52,2 al 55,1% el porcentaje de pacientes con HbA1c≤7% (figura 6) [59].

Otro de los condicionantes del control glucémico es la duración de la diabetes, pues la historia natural de la enfermedad comporta un empeoramiento progresivo tal como puede observarse en la figura 7 a partir de los datos de la evaluación GEDAPS de 2007 [47]: entre 0 y 5 años aproximadamente un tercio de los pacientes tienen valores de HbA1c>7%, mientras que por encima de los 20 años afecta a más de la mitad de pacientes.

Figura 7. Cambios en el control de los factores de riesgo cardiovascular en función de la duración de la diabetes en la evaluación GEDAPS de 2007 [47]



PP: Incluye solo pacientes en Prevención Primaria (sin enfermedad cardiovascular) que disponen de determinación de LDL-Colesterol (N=2.436)
PS: Incluye solo pacientes en Prevención Secundaria (con enfermedad cardiovascular) que disponen de determinación de LDL-Colesterol (N=513)

Finalmente, si atendemos a la relación de la obesidad con la duración de la diabetes (figura 7), su prevalencia es más o menos constante en los primeros 20 años (40-42%), y cae al 31% en pacientes con más de 20 años de evolución, hecho probablemente ligado a la mayor edad de estos pacientes, la pérdida de peso que se observa en los ancianos frágiles (es uno de los criterios de fragilidad) y al sesgo de supervivencia atribuible a que los pacientes con síndrome metabólico probablemente fallecen a edades más tempranas que los pacientes con sobrepeso o normopeso. Sin embargo, debemos comentar la paradoja del IMC y la mortalidad en la diabetes que se ha descrito en pacientes con enfermedad cardiovascular y especialmente insuficiencia cardiaca, habiéndose observado una menor mortalidad en los pacientes con sobrepeso u obesidad [134–136]. Así pues, en los pacientes de edad avanzada con comorbilidades la pérdida involuntaria de peso puede ser un signo de alarma, sin embargo, dicha pérdida sigue siendo deseable en la mayor parte de los pacientes aunque tengan enfermedad cardiovascular[136].

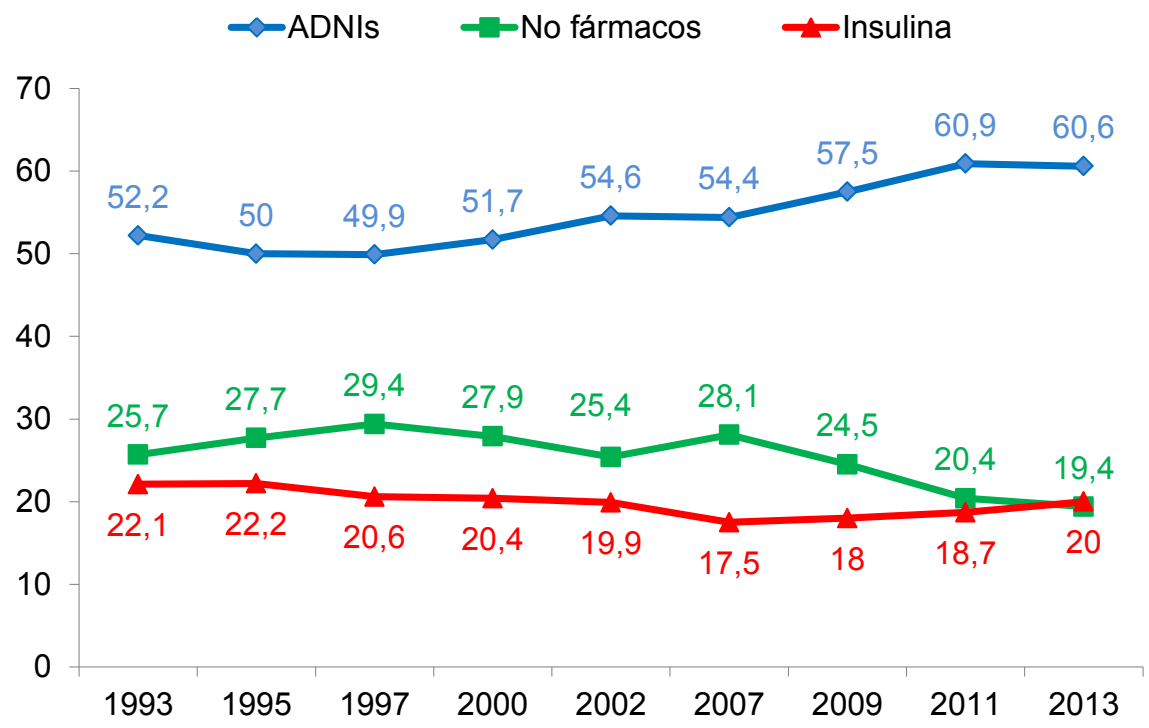
5.6. Evolución del tratamiento antidiabético

En la figura 8 se muestra la evolución del manejo terapéutico de la hiperglucemia, por escalones terapéuticos. Los datos que se muestran son de las evaluaciones GEDAPS de 1993 a 2002 [44] y a partir de 2007 los del SIDIAP, pero solo cada dos años para facilitar su interpretación temporal [59].

Durante las evaluaciones GEDAPS se observó un progresivo aumento del tratamiento con fármacos orales (solos o en combinación), pasando del 52% en 1993 al 60% en 2007, y una disminución de los tratados únicamente con dieta y ejercicio (del 26 al 22% en 2007). Al mismo tiempo, el porcentaje de insulinizados descendió del 22% en 1993 al 17% en 2007 [44]. Los datos de 2007 que se muestran en la figura 8 son los de la evaluación SIDIAP y el valor (17,5%) es prácticamente el mismo que el mencionado de la evaluación GEDAPS (17%) [59].

En las evaluaciones SIDIAP el porcentaje de pacientes sin tratamiento farmacológico descendió de manera notable y progresiva del 28% en 2007 al 19% en 2013 mientras que aumentó el tratamiento con antidiabéticos no insulínicos (ADNIS) (del 54,5% al 61%) y el tratamiento insulínico (del 17,5 al 20%) [59]. Dado que durante este mismo período aumentó notablemente la prevalencia registrada cabe suponer que en los primeros años un número considerable de pacientes, a pesar de estar recibiendo tratamiento antidiabético, no tenían todavía registrado el diagnóstico de DM2. Para evitar esta limitación se hubiera tenido que hacer una extracción incluyendo todos los pacientes tratados con algún antidiabético y con algún valor de HbA1c>6,5% para poder captar a los pacientes aún por codificar como DM2. En este sentido, en un estudio de validación del diagnóstico de diabetes en la base de datos de SIDIAP de 2014, 8.707 pacientes (aproximadamente un 2,2% del total de diabéticos) recibían tratamiento antidiabético sin constar ningún código de diabetes o prediabetes [62], lo que hace pensar que aunque actualmente ya no sea un problema de gran magnitud, quizás pudo serlo en los primeros años.

Figura 8. Tratamiento antidiabético según escalón terapéutico en las evaluaciones GEDAPS 1993-2002 [44] y SIDIAP 2007-2013 [59].

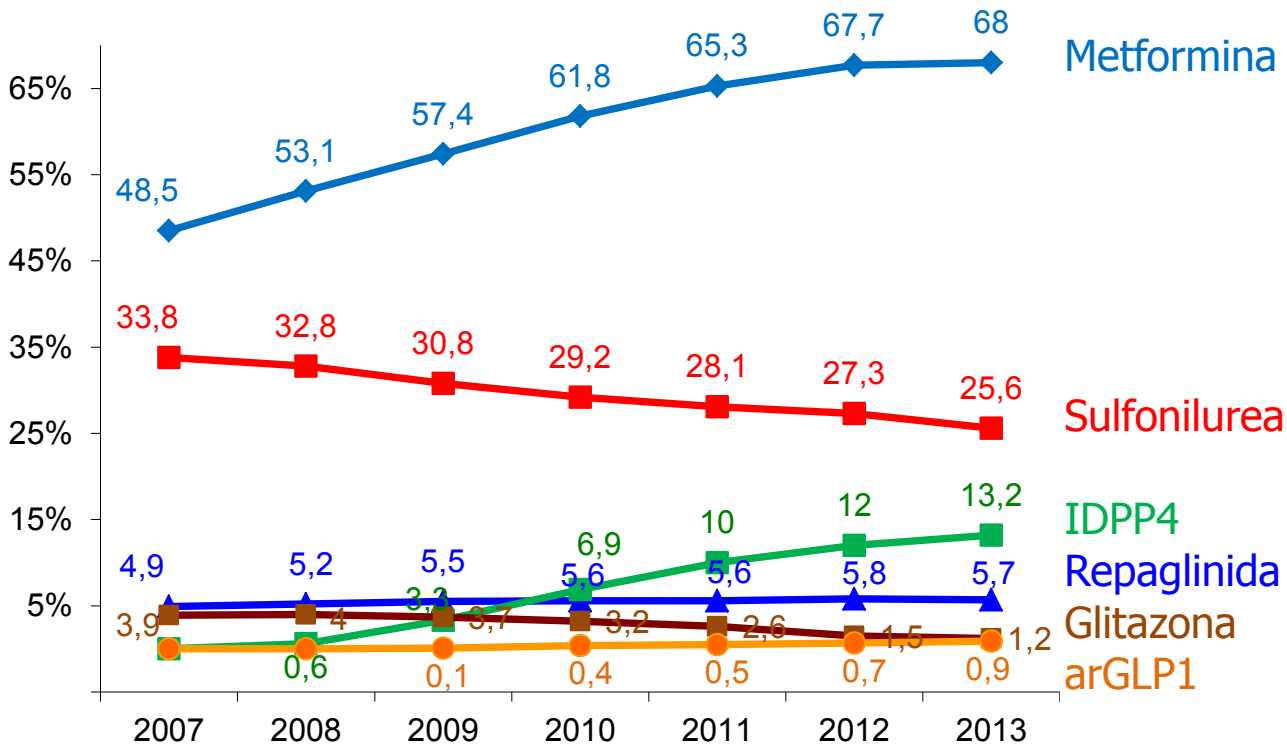


ADNIs: Antidiabéticos No Insulínicos.

Insulina incluye tanto en monoterapia como en combinación con ADNIs

En cuanto a la prescripción de cada uno de los fármacos o grupos de antidiabéticos, disponemos de datos individualizados del SIDIAP, pero no de las evaluaciones GEDAPS. Entre 2007 y 2013 aumentó considerablemente el uso de metformina e inhibidores de la Dipeptidil Peptidasa 4 (DPP4) pasando del 48,5 al 68% y del 0 al 13,2%, respectivamente, disminuyendo el de sulfonilureas y glitazonas (del 33,8 al 25,6% y del 3,9 al 2,2%) y siendo muy baja la prescripción de agonistas del receptor del Glucagón Like Peptide-1 (GLP-1) (del 0 al 0,9%) [59], tal como se puede ver en la Figura 9.

Figura 9. Prescripción de fármacos antidiabéticos no insulínicos en las evaluaciones SIDIAP de 2007 a 2013 [59].



arGLP1: análogos del receptor del Glucagón Like Peptide 1

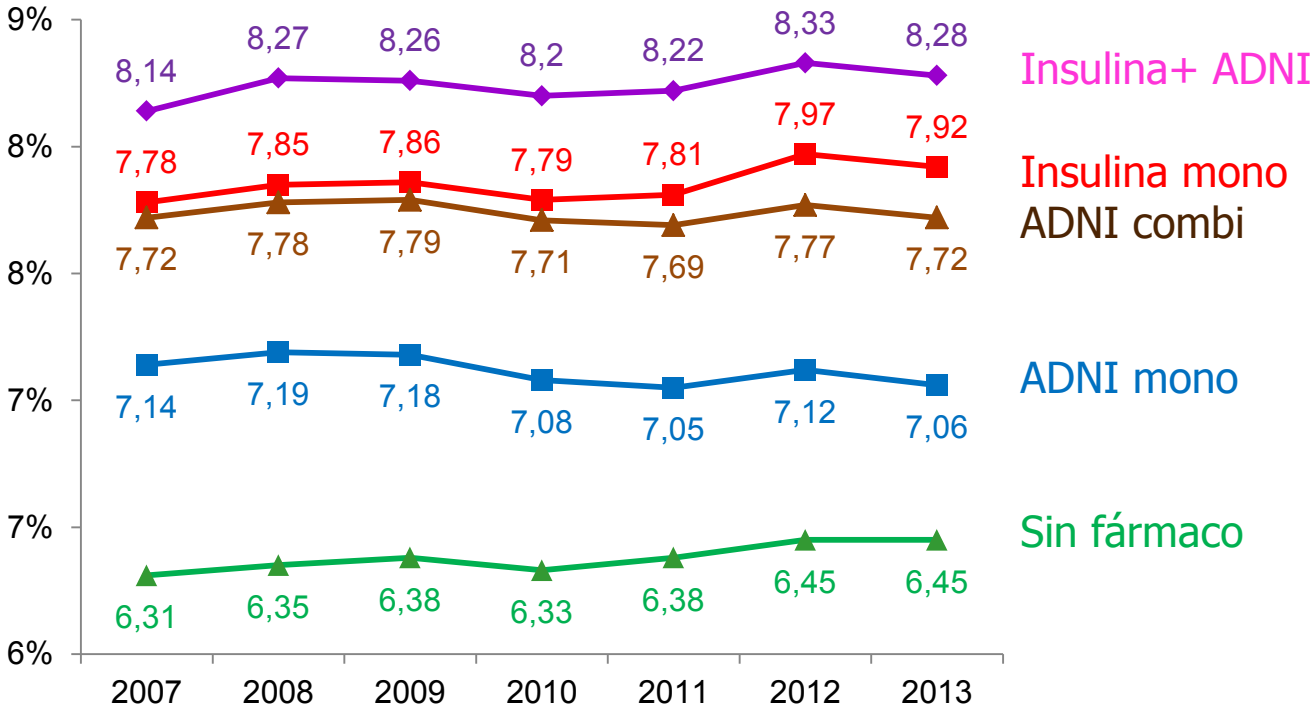
iDPP4: inhibidores de la Dipeptidil Peptidasa 4.

El crecimiento de los inhibidores de la DPP4, junto a un descenso paralelo de las sulfonilureas, se ha observado en España [137,138], Italia [139], Japón [140,141], Portugal [142], Canadá [143], Reino Unido [144] y Estados Unidos [79,145,146], pero no en Noruega [147] y Holanda [142]. A destacar que en el estudio del Reino Unido, realizado entre 2000 y 2013, la prescripción de metformina pasó del 55,4 al 83,6%, las sulfonilureas bajaron del 64,8% al 41,4%, y los inhibidores de la DPP4 llegaron al 15,4% [144], mostrando éstos últimos una tendencia similar a la observada en nuestro estudio.

Es muy interesante analizar el grado de control glucémico en los diferentes escalones terapéuticos (figura 10), que se mantiene más o menos estable a lo largo del período de 2007 a 2013 (SIDIAP), pero siempre con un peor control

glucémico en los pacientes tratados con insulina y con una leve tendencia a empeorar con el paso de los años evaluados [59].

Figura 10. Valores de HbA1c media en cada escalón terapéutico en las evaluaciones SIDIAP de 2007 a 2013 [59]



ADNI: Antidiabéticos No Insulínicos

En general, a medida que aumenta la complejidad del tratamiento aumenta el valor de HbA1c media, y esto se debe a que normalmente se intensifica el tratamiento cuando los valores superan el objetivo establecido en cada paciente, y habitualmente por encima del 8% [50], que es el objetivo general para la evaluación de la calidad de la atención y la incentivación económica del ICS [84]. Probablemente este dintel sea el más adecuado para intensificar cuando es preciso añadir un tercer fármaco o insulina, pero no es justificable en los pacientes en tratamiento no farmacológico o en monoterapia en los que debería ser cuando sobrepasan el 6,5 o el 7%. Así por ejemplo en un estudio multicéntrico realizado en atención primaria en España el cambio de

monoterapia a biterapia se produjo con valores de HbA1c de 8,4% [148], es decir, muy por encima del valor del 6,5 o 7% que establecen las guías para estos casos [34,35,41,45,149]. En cambio, la insulinización se suele producir con valores medios alrededor del 9%, tal como se observó en los pacientes españoles de dos estudios multicéntricos europeos (INSTIGATE y SOLVE), que fueron de 9,2 y 8,9%, respectivamente [150,151], ambos muy por encima del valor del 8% que establece el ICS como límite máximo del control aceptable para todos los pacientes [84].

5.7. Evolución de la prevalencia de complicaciones crónicas de la diabetes

Cuando hablamos de indicadores de resultados finales nos referimos básicamente a las complicaciones de la diabetes y por tanto estas no dependen únicamente de la actividad de los profesionales de atención primaria y son más bien el resultado del conjunto del sistema sanitario. El papel protagonista del paciente en el manejo del día a día de su enfermedad y, una vez aparecen las complicaciones, el papel de los servicios especializados y hospitalarios tienen también un papel destacado. Además, algunos recursos específicos pueden reducir el impacto en las complicaciones agudas como la hipoglucemia, el coma cetoacedótico o hiperosmolar (Hospitales de día) o crónicas como las úlceras o amputaciones (Unidades de Pie Diabético). En los pacientes diabéticos, las mejoras del conjunto del sistema sanitario han llevado a reducciones de la morbilidad y la mortalidad en los países desarrollados, aunque estas reducciones, especialmente en la mortalidad, son inferiores a las observadas en pacientes no diabéticos [3,12].

En la tabla 2 se puede ver la evolución en la prevalencia de las complicaciones micro y macrovasculares. Las complicaciones macrovasculares, cardiopatía isquémica y Accidente Vascular Cerebral (AVC), se han mantenido más o menos estables durante el primer periodo (GEDAPS) (tabla 2). Sin embargo, durante el período 2007 a 2013 (SIDIAP), hay un descenso inicial del registro del AVC, con un incremento posterior notable (del 6,6 al 8,4%) por una

probable mejora en el registro (tabla 2). Una posible explicación es que el indicador AVC incluye también los accidentes isquémicos transitorios (AIT), que, por no dejar secuelas, probablemente fueron menos registrados como antecedente en los primeros años de la informatización, y posteriormente se fueron incorporando a la lista de problemas. Así por ejemplo, los datos de la Encuesta de Morbilidad Hospitalaria del Instituto Nacional de Estadística del año 2011 registraron 116.017 casos de AVC y 14.933 de AIT[152], lo que representaría que al menos un 11% de los AVC serían AIT. Es conocido que uno de cada tres pacientes que ha sufrido un AIT sufrirá un ictus establecido durante el año siguiente si no se toman las medidas adecuadas, de ahí la importancia de su registro y la necesidad de una intervención intensiva sobre los factores de riesgo cardiovascular [152]. En cambio, la prevalencia registrada de la cardiopatía isquémica se ha mantenido más o menos igual durante ambos períodos, probablemente por la necesidad de controles clínicos periódicos que recaen fundamentalmente en los médicos de atención primaria. Además, aunque se ha observado que la incidencia de enfermedad coronaria sigue un ritmo decreciente en los países desarrollados, la disminución de la mortalidad por síndrome coronario agudo y el envejecimiento progresivo de la población hacen suponer que el número absoluto de episodios coronarios y, por lo tanto, la prevalencia de enfermedad coronaria no disminuirán o incluso aumentarán en un futuro próximo[153].

En cuanto a la insuficiencia cardiaca y la arteriopatía periférica, que no estaban incluidas en los indicadores del GEDAPS, los datos SIDIAP muestran también un incremento progresivo de la prevalencia también atribuible en gran parte a una mejora en el registro. En el caso de la arteriopatía periférica pasó del 2,6 al 4,9% y en el de la insuficiencia cardiaca del 4,1 al 6,2% (tabla 2). Datos epidemiológicos sitúan las prevalencias en aproximadamente del 20% [154] y del 10% [155] respectivamente, por lo que es esperable que en los próximos años aumente la prevalencia registrada.

Analizando estas complicaciones por sexos, se constata que la enfermedad cardiovascular es más frecuente en varones (22,3% vs 13,8%), básicamente por la mayor prevalencia de enfermedad coronaria (15,9% vs 8,6%), arteriopatía periférica (5,7 vs 2%) y, en menor grado, AVC (6,4 vs 5,3%) [57,58].

En cambio, la insuficiencia cardiaca lo es más en mujeres (4,7 vs 6,6%), ya que aparece en edades más avanzadas y las mujeres, por su mayor esperanza de vida tienen más posibilidades de padecerla [155]. Así, en todas las evaluaciones, GEDAPS y SIDIAP, la edad de las mujeres es mayor [44,58,59]. Este hecho es conocido y reportado en otros estudios de prevalencia de la insuficiencia cardiaca [155,156].

En cuanto a la insuficiencia renal crónica, medida directamente a partir de los valores de filtrado glomerular (calculado mediante la ecuación del MDRD - Modification of Diet in Renal Disease- directamente por los laboratorios de referencia) [157], se ha mantenido estable durante el período 2007-2013 alrededor del 20% [59]. Los valores de las evaluaciones GEDAPS, salvo la de 2007 que ya incluyó el criterio del filtrado glomerular [49], no son comparables con las del SIDIAP pues el criterio, en el primer caso, era la presencia del diagnóstico de insuficiencia renal registrado en la lista de problemas o la elevación de creatinina >1,5 mg/dl en varones y >1,4 en mujeres, cifras equivalentes a valores de filtrado glomerular muy inferiores a los criterios actuales y más próximos a la insuficiencia renal grave. En la tabla 3 se puede comprobar que la prevalencia de insuficiencia renal fue similar en la evaluación GEDAPS (22,9%) [49] y la del SIDIAP (21,5%) de 2007 [59], en ambos casos calculadas mediante la ecuación del MDRD [157]. En otro estudio multicéntrico en atención primaria específicamente orientado a detectar la enfermedad renal, el estudio PERCEDIME2, la prevalencia de insuficiencia renal fue también del 18% [158].

En relación a las complicaciones microvasculares, las lesiones del pie diabético (úlceras y amputaciones) mostraron un importante descenso en las evaluaciones del GEDAPS con una reducción a una tercera parte (del 9,5 al 3,2%, tabla 2) [44]. Este resultado, tan relevante desde el punto de vista de la calidad de vida de los pacientes y los costes para el sistema sanitario [8,9,159,160], está probablemente relacionado con las tareas de enfermería en la educación de los pacientes y la detección precoz de pacientes con pie de riesgo, pero también con el incremento de la prevalencia de la DM2 al diagnosticarse pacientes cada vez en fases más precoces de la enfermedad y por tanto con más posibilidades de prevención de esta complicación.

Finalmente, el papel de la cirugía vascular menos agresiva [161] y la incorporación de recursos específicos para el manejo de esta complicación en los servicios hospitalarios (Radiología intervencionista, Unidades del pie diabético etc.)[162] sin duda han contribuido a reducir el número de amputaciones y en casi la mitad de casos a limitarla a los dedos [163–165]. En la extracción de los datos del SIDIAP 2007-2013 no ha sido posible analizar la prevalencia del pie diabético ya que no se disponía de un código CIE-10 específico, lo que hizo imposible su recogida. La inespecificidad de los códigos CIE-10 para las úlceras (pueden ser también venosas o de decúbito, por ejemplo) o de las amputaciones (pueden ser de cualquier parte del cuerpo) también han impedido analizar ambas complicaciones del pie diabético por separado. Actualmente se dispone ya de un código específico "pie diabético", por lo que en futuros estudios podrá ser debidamente estudiado. En el caso de las amputaciones la disminución observada en las evaluaciones GEDAPS también se ha descrito en el conjunto de España en el período 2001 a 2012[163], en Andalucía entre 1998 y 2006 [165] y en Tarragona entre 2007 y 2013[164]. También en Estados Unidos se han reducido casi en un 33% desde 1993 a 2007, tendencia que también se ha observado en otros países como Holanda o Escocia[3]. Las amputaciones se han considerado como un indicador de resultados centinela ya que se puede ver afectado por el manejo de varios factores de riesgo cardiovascular importantes (control glucémico, presión arterial y abandono del tabaquismo) y la capacidad del sistema sanitario para cribar, estratificar el riesgo y tratar los pies de riesgo y las úlceras [3].

También existe un notable infraregistro de la neuropatía diabética (alrededor del 2% en el SIDIAP, datos no publicados), por lo que no ha sido tenido en cuenta en las evaluaciones GEDAPS ni SIDIAP. La dificultad del diagnóstico, muchas veces basada únicamente en síntomas subjetivos, también repercute negativamente en su registro. La prevalencia de la neuropatía varía notablemente en estudios realizados mediante revisión de historias en nuestro medio: un 5% de un total de 1.495 pacientes atendidos en tres EAP de Terrassa en 1999)[166] y un 8,6% en un estudio multicéntrico español en 443 pacientes atendidos durante 2012[85]. En cambio en un estudio realizado sobre una base de datos de atención primaria

del Reino Unido fue solo del 1,1% [143], lo que trasluce seguramente el mismo problema de infraregistro en los sistemas de historia clínica informatizada en ambos países. Finalmente, recordar que hasta un 50% de casos de neuropatía son asintomáticos, por lo que si no se busca activamente su presencia pueden pasar desapercibidos para el profesional de atención primaria [89,167].

Cabe señalar la progresiva reducción de la prevalencia de la retinopatía en las evaluaciones del GEDAPS hasta 2007, pasando del 18,8% al 8,6% [44] (tablas 2 y 3). Sorprende la elevada prevalencia de retinopatía en la primera evaluación GEDAPS, que por ser la primera pudo ser menos precisa, y los fondos de ojo informados como retinopatía esclero-hipertensiva, u otras causas de retinopatía o pérdida de la agudeza visual, pudieron ser considerados erróneamente como retinopatía diabética. También llama la atención que en los datos de las evaluaciones SIDIAP se observa un incremento progresivo en la prevalencia de retinopatía del 4% en 2007 al 7,6% en 2013. El hecho de que en las evaluaciones SIDIAP se partiera de valores iniciales inferiores al 8,6% del GEDAPS del 2007 (tabla 3), y que este sea el mismo valor observado en 2013 en el SIDIAP probablemente refleja una mejora del registro, aunque ambos valores todavía son inferiores a los esperables [90,91]. Así, la prevalencia observada a partir del análisis de los resultados de las 108.723 retinografías registradas durante cinco años (desde el 1 de enero de 2008 al 31 de diciembre 2012) en la base de datos del SIDIAP, fue del 12,3% [60]. El hecho de que no exista un tratamiento médico y que el tratamiento dependa únicamente de los servicios de oftalmología puede condicionar que el diagnóstico pase desapercibido por el profesional de atención primaria o que no se registre adecuadamente como problema de salud. Sin embargo es indudable que tanto el cribado como el registro de sus resultados es imprescindible ya que facilita que el profesional sea consciente de la necesidad de derivar periódicamente al paciente para revisiones y/o tratamiento cuando aparece esta complicación [89,168]. Finalmente, señalar que un estudio en EEUU mostró un incremento en los tratamientos de retinopatía en pacientes ancianos atendidos por el Medicare entre 1991 y 2004, hecho que los autores atribuyeron a la reducción de la mortalidad observada durante ese

mismo período, con lo que los pacientes, al vivir más años, tienen más tiempo para desarrollar esta complicación [169].

En cuanto a prevalencia de la albuminuria (micro o macroalbuminuria), un conocido predictor de eventos y mortalidad cardiovascular [170], se ha mantenido bastante estable durante los dos períodos con valores alrededor del 16-20% [44,59], valores que, al no depender de su registro por parte de los profesionales son un fiel reflejo de la realidad y coinciden con otros estudios sobre su prevalencia [3,158,170]. Sin embargo, hay que considerar el sesgo de selección ya que probablemente la determinación se realice en pacientes más frecuentadores y/o con valores previos alterados. Además el aumento de la supervivencia de los pacientes con diabetes hace prever que en el futuro aumentará la prevalencia de enfermedad renal crónica, así como del resto de complicaciones crónicas de la diabetes [3,89].

Una consideración final sobre la reducción de la mortalidad por causa de la diabetes que se ha observado en la mayoría de países en las últimas tres décadas[3] y que, aunque no ha sido específicamente analizado en las evaluaciones GEDAPS y SIDIAP, también ha sido descrita en España [171]. Así, en el periodo 1998-2013, se ha observado una reducción de la tasa de mortalidad estandarizada por DM del 25,3% en los varones y el 41,4% en las mujeres [171]. Como hemos mencionado anteriormente la mortalidad actúa en competencia con las complicaciones y por tanto si se reduce la mortalidad aumenta la supervivencia y por tanto cabe esperar un aumento de la prevalencia de éstas a menos que se intervenga de manera multifactorial en los factores de riesgo de las complicaciones [3]. El hecho de que en el período estudiado exista una cierta estabilidad en las complicaciones macrovasculares (IAM y AVC) o incluso una reducción en algunas de las microvasculares (retinopatía y pie diabético), a pesar de la reducción de la mortalidad, habla en favor de una mejora en la prevención de éstas mediante el abordaje del conjunto de factores de riesgo y la educación de los pacientes, la detección precoz y, finalmente, cuando aparecen, su manejo clínico.

5.8. Diferencias entre las evaluaciones GEDAPS y SIDIAP de 2007

Ya hemos comentado previamente que la principal diferencia entre ambos tipos de evaluaciones es que las del GEDAPS se basaban en pequeñas muestras de pacientes de cada centro (audits) mientras que con el SIDIAP se puede acceder a todos los pacientes atendidos por el ICS. Además, el hecho de que la participación en las evaluaciones GEDAPS fuera voluntaria y que la persona del centro que las hacía formaba parte de una red de MCC, puede hacer suponer que se tratara de centros más consolidados o motivados respecto de la DM2 y que podrían ofrecer una atención de mayor calidad y por tanto unos mejores resultados en los indicadores de proceso. Estas diferencias metodológicas se ponen especialmente de manifiesto en la evaluación de 2007 que fue la única del GEDAPS que se hizo a partir de los registros informáticos [47] y que vamos a comparar con las del SIDIAP del mismo año [59] (tabla 3). El hecho de que ambas se basen en los registros informáticos nos puede desvelar las ventajas e inconvenientes de cada abordaje.

En primer lugar, hay que resaltar que en las evaluaciones GEDAPS quedaban excluidos los pacientes en situación terminal, atención domiciliaria, exclusivamente controlados en otros dispositivos asistenciales o que no tuvieran ninguna visita durante el año evaluado, lo que contribuye a que se disponga de un mayor número de variables (determinaciones de peso, presión arterial y pruebas de laboratorio) (tabla 3). Así por ejemplo en la evaluación GEDAPS de 2007 el 89% de los pacientes tenían al menos una determinación de HbA1c mientras que solo disponían de ella un 65% del conjunto del ICS (SIDIAP) de ese mismo año. Muy pocos pacientes en las evaluaciones GEDAPS carecían de la presión arterial (siempre por encima del 90%) cayendo notablemente en la del SIDIAP de 2007 (79,5%). La diferencia es aún mayor en el caso del IMC, disponible en el 82,3% de los pacientes en la evaluación GEDAPS y solo en el 65,2% en SIDIAP. En las evaluaciones SIDIAP no se tiene acceso a los datos individuales (datos anonimizados), por lo que al incluir pacientes que se controlan en otros niveles asistenciales (hospitales, consultas

privadas), o pacientes menos cumplidores o con dificultades para asistir a las visitas de control (por ejemplo, en edad laboral) hay una menor disponibilidad de pruebas y datos. En cambio, en las evaluaciones GEDAPS estos pacientes eran descartados y sustituidos por otro paciente del mismo sexo que sí había acudido a su EAP al menos en una ocasión durante el año evaluado, aunque fuera por cualquier otro motivo, un resfriado o una lumbalgia, por lo que siempre había pacientes a los que les faltaban variables.

Pero la diferencia más relevante es que en las evaluaciones GEDAPS la revisión individual de la historia clínica, en papel o informatizada, de cada paciente permitía acceder al texto libre de la misma y, por tanto, obtener datos clínicos más completos y precisos de complicaciones y resultados de las exploraciones efectuadas durante el periodo evaluado. Por ejemplo, los informe de alta, las pruebas y resultados de analíticas realizados en el hospital de referencia, que en ocasiones no pertenece al ICS y, por tanto, no han sido volcados automáticamente en la base de datos del SIDIAP. Además, el acceso individual a los datos de los campos de texto libre permite detectar errores como, por ejemplo, la fecha del diagnóstico que en las evaluaciones en bases de datos poblacionales son imposibles de comprobar mientras que la evaluación individual de cada paciente permite corroborarlo con una mayor exactitud. Así, por ejemplo, mientras que la duración de la diabetes en la del GEDAPS fue de 7 años en la del SIDIAP fue de sólo de 5,4 años (tabla 3). Esto se debe probablemente a que hasta 2010 el programa e-CAP no permitía el cambio de la fecha de diagnóstico del problema de salud y si se había registrado por defecto el día de la primera visita por la diabetes, posteriormente no se podía modificar. En el caso de la muestra GEDAPS de 2007, el evaluador podía comprobar la fecha en el campo de observaciones del diagnóstico, en el texto libre o incluso, en caso de duda, en la historia de papel que aún se guardaba en el centro. El hecho de que en las evaluaciones SIDIAP haya aumentado progresivamente la duración de la diabetes (de 5,4 años en 2007 a 7 años en 2013, la misma duración que en la evaluación GEDAPS de 2007 (tabla 2), apoya esta hipótesis. Esto también se constata en la mayor prevalencia de retinopatía registrada en las evaluaciones GEDAPS, ya que muchas veces la información de las revisiones oftalmológicas antes de la

instauración de los programas de cribado mediante retinografías era registrada en el curso clínico por parte de los profesionales que las realizaban. Así, en la evaluación del 2007, la prevalencia registrada de retinopatía en la evaluación GEDAPS fue del 8,6% [44] y sólo del 4,6% en la del SIDIAP [59] (tabla 3), aunque, tal como se ha mencionado previamente la prevalencia en las retinografías registradas de manera automatizada en el SIDIAP entre 2008 y 2012 fue del 12,3%[60]. Se debe tener en cuenta que el programa de retinografías y su registro en el SIDIAP no se generalizaron hasta después de 2007, por lo que el acceso a estos resultados implicaba un esfuerzo de búsqueda activa y posterior registro por parte de los profesionales (o los revisores, en el caso de las evaluaciones GEDAPS).

En cambio, en lo que se refiere al control de los factores de riesgo, los valores de la media de HbA1c, presión arterial, IMC, colesterol total o LDL son prácticamente similares entre las dos evaluaciones (tabla 3), lo que pone de manifiesto la validez externa de los datos de las evaluaciones GEDAPS [44]. En cambio, la prevalencia de tabaquismo y el porcentaje de pacientes no tratados con fármacos fueron menores en la muestra GEDAPS, lo que podría estar relacionada con la exclusión de pacientes que no han acudido al centro durante el año evaluado (en edad laboral o menos cumplidores).

Tabla 3. Comparación entre las evaluaciones GEDAPS y SIDIAP de 2007

	GEDAPS 2007 [47]	SIDIAP 2007 [59]
Prevalencia de DM2 registrada (%) en mayores de 14 años	5,4	4
Pacientes (N)	3.130	257.072
Características de los pacientes		
Media Edad (años)	68,8	67,7
Varones/mujeres (%)	51,5/48,5	52/48
Media Duración de la diabetes (años)	7	5,4
Media Índice Masa Corporal (kg/talla^2)	30,2	30,1
Obesidad (IMC>30 kg/m^2)	42,3	44,6
Tratamiento no farmacológico (%)	22,3	28,1
Antidiabéticos no insulínicos (%)	60,5	54,4
Insulina (sola o en combinación) (%)	17,3	17,5
Determinaciones disponibles		
Presión arterial	92,3	79,5
IMC	82,3	65,2
HbA1c	88,9	64,7
Colesterol	90,9	69
Creatinina	84,4	68
Cociente Albúmina/Creatinina	59,4	28,3
Variables de control		
Media de HbA1c sin estandarizar (%)	6,84	6,85
Media de HbA1c estandarizada DCCT (%)	-	7,16
Control glucémico HbA1c≤7% (%)	64,2	54,9
Control glucémico HbA1c≤8% (%)	83,3	79
Media de Colesterol total mg/dl	194	194,8
Control Colesterol total <200mg/dl (%)	65,6	57,1
Control Colesterol total <250mg/dl (%)	92,4	91,9
Media de Colesterol LDL (mg/dl)	115	116
Media de Triglicéridos (mg/dl)	151	150
Insuficiencia renal crónica (Filtrado Glomerular <60 ml/min)	22,9	21,5
Media de Presión Arterial (PA) (mmHg)	137/76,5	138/76,4
Control PA ≤140/90 mmHg (%)	65,9	60
Tabaquismo activo (%)	13,8	16,7
Complicaciones crónicas		
Retinopatía (%)	8,6	4,6
Albuminuria (>30mg/dl) (%)	19,5	18,7
Cardiopatía isquémica (%)	11,9	11,4
Accidente vascular cerebral (%)	6,7	6,6

La prevalencia de insuficiencia renal (21 y 23%) o de albuminuria (19%), determinadas a partir de los datos de laboratorio, no del registro del diagnóstico, fueron similares (tabla 3)[44,59]. También, en cuanto a las prevalencias de complicaciones cardiovasculares son muy similares entre las dos evaluaciones, lo que va a favor de un mejor registro de las complicaciones macrovasculares que de las microvasculares en la base de datos SIDIAP. El impacto de un evento cardiovascular tanto en la calidad de vida del paciente, con un claro antes y después, como los cambios que supone en el manejo terapéutico, favorecen su registro.

Finalmente, cabe señalar que en las evaluaciones GEDAPS participaron también algunos centros de otros proveedores diferentes del ICS, y por tanto con recursos y características organizativas probablemente diferentes, que obviamente no están incluidos en las evaluaciones del SIDIAP.

5.9. Comparación con los datos de otros países desarrollados

En los últimos 20 años, se han publicado numerosos estudios observacionales sobre el grado de control de la DM2, sin embargo, comentaremos únicamente algunas realizadas a partir de grandes bases de datos de pacientes y obviaremos las realizadas a partir de muestras pequeñas o locales. El registro informatizado de los datos clínicos de los pacientes proporciona un gran potencial para la investigación en Atención Primaria. Así lo demuestran las cada vez más numerosas publicaciones de estudios observacionales de Alemania [72], Reino Unido [77,80], Italia [76], Suecia [74,81], Noruega [75], Estados Unidos [73,78,79] o del conjunto de Europa [71] en la misma década que la primera publicación SIDIAP sobre datos de 2009 [53]. En el caso del sistema sanitario español, al igual que sucede con el británico, hay una ventaja adicional: prácticamente toda la población tiene asignado un equipo de atención primaria perteneciente a un proveedor de servicio público, ya que la asistencia sanitaria es universal y gratuita. Como ya hemos comentado previamente, los médicos de atención primaria son la puerta de entrada del sistema y los responsables del manejo de las patologías crónicas más prevalentes y de la prescripción

farmacéutica incluso en los casos más avanzados o complicados que son visitados en los servicios de segundo o tercer nivel [63].

En la tabla 4 se muestran los resultados de algunos estudios observacionales para poder compararlos con los del estudio del SIDIAP en Cataluña de 2009 [53] que fue el primero en publicarse. Hemos optado por mostrar los datos SIDIAP del año 2009 para que sean más parecidos temporalmente, pues el retardo habitual en las publicaciones hace que la mayoría de ellas aparezcan varios años después del año en que se efectuó la evaluación, tal como se puede ver en la misma tabla.

La comparación de los resultados es difícil pues junto a los diferentes sistemas sanitarios se añade las diferencias metodológicas (algunas no diferencian entre DM1 y DM2 y en muchos casos los puntos de corte de los objetivos son diferentes), la procedencia de los pacientes (atención primaria o unidades especializadas de diabetes), el tamaño de las muestras o el año de su realización. Cabe señalar que en el caso del grado de control las comparaciones son especialmente difíciles ya que los puntos de corte para los tres principales indicadores de control (HbA1c, colesterol LDL y presión arterial son diferentes en cada estudio), por lo que es preferible comparar las medias de cada uno de los valores. En general, podemos afirmar que los resultados de la atención a las personas con DM2 observados en Cataluña son similares o incluso mejores que los de otros países industrializados. Así, por ejemplo, los datos provenientes del Reino Unido, con un sistema sanitario parecido al nuestro, muestran un grado de control inferior en prácticamente todos los indicadores [80].

Tabla 4. Comparación del grado de control de los factores de riesgo cardiovascular en diferentes estudios transversales en Europa y Estados Unidos

Referencia y año de publicación	Cooper 2009[75]	CDS 2008[76]	Van Hateren 2012[82]	Gunathilake 2010[80]	Vinagre 2012[53]	Lipska 2016[79]	Odesjo 2015[81]
Año evaluado	2005	2005	2008	2009	2009	2009	2011
País (región o base de datos)	Noruega (Nacional)	Italia (Sicilia)	Holanda (Zwolle)	UK (THIN)	España (Catalunya)	EEUU (Federal)	Suecia (VGR)
Tamaño (N)	2.699	~12.000	27.438	49.919	286.791	538.239	84.053
HbA1c media (%)	7,15	7,3	7,2	7,6	7,15	-	7,2
Control glucémico (%) (valor límite HbA1c)	69,2 (≤7,5)	59,9 (≤7)	56,6 (<7)	44 (≤7)	56,1 (≤7)	55,8 (≤7)	56,6 (<7)
Control Colesterol Total (%) (valor límite mg/dl)	52,9 (<195)	-	61,1 (CT/HDL<4)	53,8 (≤155)	61,3 (≤200)	-	-
Control Colesterol LDL (%) (valor límite mg/dl)	-	44 (<100)	-	32,6 (≤77)	37,9 (≤100)	-	47,3 (<97)
Control Presión Arterial (%) (valor límite mmHg)	65,7 (≤140)	48,5 (≤130/85)	47,7 (<140)	41,6 (≤130)	66,1 (≤ 140/90)	-	74,6 (<140/90)

CT/HDL: Cociente Colesterol Total/Colesterol HDL
THIN: The Health Improvement Network database
VGR: Västra Götalands Region

5.10. Limitaciones de la tesis

Ya se han comentado previamente las principales limitaciones metodológicas de ambos abordajes, el muestral (GEDAPS) y el poblacional (SIDIAP). Sin embargo, en este apartado queremos resaltar los aspectos que no han sido abordados y de los que por tanto no tenemos información: la adherencia de los pacientes y las hipoglucemias.

En primer lugar, la adherencia de los pacientes, tanto en lo que se refiere a los estilos de vida como de los tratamientos farmacológicos. Constituye una de las principales barreras para conseguir un control glucémico adecuado [112,116,122]. Esta información que no es recogida de manera sistemática por los profesionales, no ha podido ser valorada en ninguna evaluación. Actualmente se dispone ya de herramientas en el eCAP para valorar el cumplimiento farmacológico ya que disponemos de información sobre la prescripción recogida en las farmacias por el paciente. Todo ello nos permitiría su evaluación y constituye uno de los proyectos futuros previstos por el grupo DAP_CAT. En cuanto a la adherencia a los estilos de vida, aunque se contempla en los registros electrónicos, continúa siendo una asignatura pendiente pues no es recogido sistemáticamente por los profesionales.

Otro de los aspectos limitantes en el control glucémico es la aparición de hipoglucemias, relacionadas principalmente con el tratamiento con sulfonilureas y/o insulina y que puede tener consecuencias dramáticas para el paciente y costes elevados al sistema [143,172–178]. El escaso registro de los eventos y la dificultad de diferenciar si se trata de un antecedente, de uno o varios eventos o del riesgo aumentado de padecerlos, hace inviable su análisis a partir de la base de datos. El estudio de las hipoglucemias requiere de diseños prospectivos específicos, combinando datos de otros registros (sistemas de emergencias, urgencias hospitalarias etc.…) y entrevistas a pacientes, que están fuera del alcance de nuestro grupo en estos momentos.

Finalmente, resaltar la necesidad de crear una cultura de registro preciso y adecuado en los profesionales con el fin de facilitar la investigación en atención

primaria. La baja prevalencia de algunas de las complicaciones al inicio y su incremento a lo largo del tiempo indica que cada vez se registra más y mejor, sin embargo, aunque queda mucho por mejorar. En ese sentido los sistemas informatizados de alarmas y las ayudas en la toma de decisiones de la historia clínica informatizada así como el feedback inmediatos de los indicadores de proceso pueden contribuir notablemente a su mejora [103]. En el año 2003 el ICS implantó para sus profesionales un sistema de retribución variable vinculado a indicadores, sistema que se fue mejorando, generalizando y unificando durante los años siguientes. En 2006 se complementó dicho sistema con un acuerdo anual llamado Acord de Gestió entre la dirección de la institución y los distintos EAP basado en el cumplimiento anual de un conjunto de indicadores. La informatización completa de las consultas y la necesidad de evaluar los indicadores permitieron, en 2006, la puesta en funcionamiento de un sistema de información clínica llamado Sistema d'Informació dels Serveis d'Atenció Primària (SISAP), que tiene por objetivo proporcionar información, fundamentalmente de gestión clínica, a los distintos integrantes del sistema (estructuras de gestión, equipos y profesionales) útil para el desarrollo de sus distintas funciones, para servir como herramienta para mejorar la gestión clínica de los profesionales de atención primaria y, en definitiva, el estado de salud de sus respectivas poblaciones [84].

La incentivación económica (*pay for performance*) se ha mostrado eficaz en la mejora del registro de las actividades en diferentes países [77,81,179–182] aunque puede llevar a registrar preferentemente algunas actividades en detrimento de otras que no están incentivadas [182]. Además, en algunos casos, las mejoras a corto plazo observadas suelen estabilizarse o incluso reducirse con el paso del tiempo [77]. En nuestro caso, el impacto de la incentivación económica en el ICS no ha sido específicamente analizado y aunque no hay publicaciones al respecto, las mejoras progresivas en algunos indicadores de proceso (tabla 1) [83] son probablemente consecuencia de esta política basada en el *pay for performance*. El SISAP constituye indudablemente una herramienta valiosa en la mejora de la atención a las patologías crónicas. Al margen de la incentivación económica, el feedback inmediato que ofrece a los profesionales de sus propios resultados en comparación con el del conjunto de profesionales

de su centro, su área geográfica y de todos los centros del ICS puede constituir un estímulo para la mejora de la calidad de la atención [84].

5.11. Propuestas de mejora para el futuro

Después de analizar las tendencias de los indicadores de proceso y resultados en el periodo 1993-2013, creemos necesario señalar algunos puntos de mejora que probablemente habría que priorizar en los próximos años en Cataluña y que han sido propuestos por el grupo DAP_CAT en un monográfico de la Agència de Qualitat i Avaluació Sanitàries de Catalunya del Departament de Salut de la Generalitat de Catalunya [83] y en la revista electrónica *Diabetis Avui* de la Associació Catalana de Diabetis [64].

- Establecimiento de programas universales de detección de riesgo y prevención de la DM2. Probablemente, el mejor lugar para iniciar la prevención de la DM2 es en las escuelas con una educación sanitaria orientada a prevenir la obesidad y mejorar la alimentación e incrementar el ejercicio físico.
- Estandarización de las prácticas, especialmente en lo que se refiere a las tareas de prevención primaria y secundaria de las complicaciones mediante un control metabólico adecuado a las características de la persona
- Estandarización de los cuidados de enfermería
- Ofrecer educación individualizada y grupal adecuada a cada paciente
- Establecer o mejorar los programas específicos de cribado universal y detección precoz de las complicaciones diabéticas.
- Terminar de desarrollar los programas y circuitos de uso de los retinógrafos no midriáticos para la detección precoz de la retinopatía diabética
- Definir e implantar un modelo de atención integral al paciente con pie diabético, incluyendo la organización de equipos multidisciplinares de alta resolución y la implantación de programas territoriales conjuntos entre la atención hospitalaria y la atención primaria
- Incrementar la formación y estimular la implicación de los profesionales de atención primaria en el manejo y seguimiento de la DM2

- Mantener y potenciar los modelos que permitan una mayor coordinación entre diferentes niveles asistenciales implicados en el cuidado de las personas con diabetes
- Potenciar el papel de la enfermería como gestora de casos
- Potenciar el papel del paciente como gestor de su enfermedad, y en la toma de decisiones.
- Evaluación y monitorización continuada de los resultados de salud, de la utilización de recursos y de servicios de salud.
- Superar las inequidades de género detectadas en nuestra población, dado que las mujeres diabéticas tienen un peor control metabólico y cardiovascular incluyendo la situación de prevención secundaria y los tratamientos son menos agresivos.
- Implantar estrategias para la detección y mejora del control en segmentos de población diabética mal controlada como los pacientes obesos o los más jóvenes.
- Potenciar la investigación en DM2, especialmente la clínica, epidemiológica y en servicios de salud, con aplicabilidad práctica.

Finalmente, y a modo de reflexión final, queremos resaltar que pesar de que los resultados pueden llevarnos a un relativo optimismo, existen todavía notables áreas de mejora sobre todo en lo que se refiere a la necesidad de un mejor control glucémico en los pacientes más jóvenes y un mejor control de la presión arterial y los lípidos en las mujeres, especialmente en prevención secundaria.

Los datos presentados pueden tener implicaciones para los planificadores del Sistema Nacional de Salud: en los próximos años se prevé que aumentará la prevalencia de la enfermedad y la supervivencia de los pacientes, con lo que los costes sanitarios relacionados con las complicaciones diabetes aumentaran progresivamente y esta tendencia debería ser tenida en cuenta para conseguir una mejor asignación de recursos sanitarios. Las estrategias orientadas a mejorar el control de la diabetes en atención primaria pueden ser inicialmente más costosas, pero pueden contribuir a prevenir o retrasar sus complicaciones y contener los costes crecientes de la atención a estos pacientes.

6. Conclusiones

En los últimos 20 años la atención a las personas con diabetes en Cataluña ha cambiado notablemente y atendiendo a los objetivos de esta tesis podemos resumir sus conclusiones en los siguientes puntos:

Objetivo Principal:

Se ha observado una mejora de la calidad de la atención tal como muestran las tendencias de algunos de los indicadores de proceso y de resultados, especialmente en el período GEDAPS de 1993 a 2007, y aunque hubo un retroceso al inicio del período SIDIAP, progresivamente ha mejorado hasta 2013 en que diferentes indicadores han llegado a equipararse o incluso superar a los de GEDAPS de 2007.

Objetivos Secundarios:

1. A lo largo de las dos décadas se ha producido un 63% de incremento en la prevalencia de la DM2, pasando del 3,2% en 1993 al 5,5% en 2013.
2. Tras una mejora muy marcada del control glucémico en el período 1993 a 2007, se ha producido una estabilización de la media de HbA1c entre 2007 y 2013. Esto se puede relacionar con la dificultad en conseguir una buena adherencia de los pacientes, la inercia clínica de los profesionales o la existencia de restricciones administrativas en la prescripción de nuevos fármacos, pero también a la existencia de un objetivo general de HbA1c<8%, establecido para evitar el sobretratamiento en los ancianos y que puede impedir que los más jóvenes y al inicio de la enfermedad se puedan beneficiar de un tratamiento precoz y un control más estricto.
3. Las mejoras progresivas observadas en el control de la presión arterial y el colesterol son reflejo de una actitud de los profesionales progresivamente más estricta en la prevención cardiovascular. Sin embargo, el control de ambos parámetros es peor en las mujeres, especialmente en prevención secundaria. El tabaquismo es más frecuente en los varones, y la obesidad en las mujeres. En el período GEDAPS hubo un incremento de la obesidad

muy marcado, que se ha mantenido estable durante el período SIDIAP. En cambio, el tabaquismo, que aumentó progresivamente hasta 2007 al aumentar la proporción de varones en las muestras, posteriormente se ha reducido a pesar de seguir aumentando dicha proporción, básicamente por un incremento de los pacientes que dejan de fumar.

4. La mejora progresiva en la calidad de los registros entre 2007 a 2013 ha comportado incrementos en la prevalencia de algunas complicaciones, hecho más bien relacionado con un mejor registro que con un incremento real de su incidencia. Así, las prevalencias en 2013 han llegado a ser similares a las observadas en la evaluación de GEDAPS de 2007. Existe un infraregistro en algunas complicaciones como la arteriopatía periférica o la retinopatía dado que las prevalencias observadas son inferiores a las publicadas en estudios epidemiológicos.
5. La comparación entre los resultados de las evaluaciones GEDAPS y SIDIAP de 2007 ha mostrado diferencias notables en las prevalencias de la enfermedad y las complicaciones, así como en algunos indicadores de proceso. Algunas son atribuibles a las dificultades iniciales en la informatización de la actividad clínica pero también a que en las evaluaciones GEDAPS se evaluaba individualmente la historia clínica de cada paciente, siempre y cuando hubieran acudido al menos una vez al centro durante el año evaluado, mientras que en la evaluación SIDIAP se evalúa todos los pacientes, acudan o no, y solo a partir de las variables registradas en los campos informáticos prestablecidos. Finalmente, cabe la posibilidad de que los centros participantes en las evaluaciones GEDAPS, que lo hacían voluntariamente, pudieran estar más motivados en el manejo de la enfermedad que el resto de los centros del país.
6. En cuanto a la prescripción de antidiabéticos en el período 2007 a 2013, se ha observado un aumento considerable del uso de metformina e inhibidores de la DPP4 y una disminución de sulfonilureas y glitazonas. Al mismo tiempo se ha reducido el número de pacientes sin tratamiento farmacológico y aumentado el tratamiento combinado y/o con insulina. Estas tendencias, observadas también en otros países, han incrementado el gasto en farmacia sin que se hayan acompañado de mejoras en el control glucémico.

7. Bibliografía

1. Whiting DR, Guariguata L, Weil C, et al. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Res Clin Pract* 2011; 94: 311–21.

2. Soriguer F, Goday A, Bosch-Comas A, et al. Prevalence of diabetes mellitus and impaired glucose regulation in Spain: the Di@bet.es Study. *Diabetologia* 2012; 55: 88–93.

3. Gregg EW, Sattar N, Ali MK. The changing face of diabetes complications. *Lancet Diabetes Endocrinol* 2016; 4: 537–547.

4. Mata-Cases M, De Prado-Lacueva C, Salido-Valencia V, et al. Incidence of complications and mortality in a type 2 diabetes patient cohort study followed up from diagnosis in a primary healthcare centre. *Int J Clin Pract* 2011; 65: 299–307.

5. Krans HMJ, Porta M, Keen H, et al. *Diabetes care and research in Europe: the St Vincent Declaration action programme implementation document.* Copenhaguen, 14 December 1992.

6. Kelly TN, Bazzano LA, Fonseca VA, et al. Systematic review: Glucose control and cardiovascular disease in type 2 diabetes. *Ann Intern Med* 2009; 151: 394–403.

7. Mata Cases M, Roset Gamisans M, Badia Llach X, et al. [Effect of type-2 diabetes mellitus on the quality of life of patients treated at primary care consultations in Spain]. *Aten primaria* 2003; 31: 493–9.

8. Clarke P, Gray A, Legood R, et al. The impact of diabetes-related complications on healthcare costs: Results from the United Kingdom Prospective Diabetes Study (UKPDS Study No. 65). *Diabet Med* 2003; 20: 442–450.

9. Alva ML, Gray A, Mihaylova B, et al. The impact of diabetes-related complications on healthcare costs: New results from the UKPDS (UKPDS 84). *Diabet Med* 2015; 32: 459–466.

10. Mata M, Antoñanzas F, Tafalla M, et al. El coste de la diabetes tipo 2 en España. El estudio CODE-2. *Gac Sanit* 2002; 16: 512–20.

11. Lopez-Bastida J, Boronat M, Moreno JO, et al. Costs, outcomes and challenges for diabetes care in Spain. *Global Health* 2013; 9: 17.

12. da Rocha Fernandes J, Ogurtsova K, Linnenkamp U, et al. IDF Diabetes Atlas estimates of 2014 global health expenditures on diabetes. *Diabetes Res Clin Pract* 2016; 117: 48–54.

13. Ballesta M, Carral F, Olveira G, et al. Economic cost associated with type II diabetes in Spanish patients. *Eur J Heal Econ* 2006; 7: 270–5.

14. Kanavos P, Aardweg S Van Den, Schurer W. Diabetes Expenditure, Burden of Disease and Management in 5 EU Countries. *LSE Heal* 2012; 1–113.

15. Crespo C, Brosa M, Soria-juan A, et al. Costes directos de la diabetes mellitus y de sus complicaciones en España (Estudio SECCAID : Spain estimated cost Ciberdem-Cabimer in Diabetes). *Av Diabetol* 2013; 29: 182–189.

16. Mata-Cases M, Casajuana M, Franch-Nadal J, et al. Direct medical costs attributable to type 2 diabetes mellitus: a population-based study in Catalonia, Spain. *Eur J Heal Econ* 2016; 17: 1001–1010.

17. Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud http://www.msssi.gob.es/organizacion/sns/planCalidadSNS/pdf/excelencia/cuidadospaliativos-diabetes/DIABETES/Estrategia_en_diabetes_del_SNS_Accesible.pdf (2012, accessed 22 October 2016).

18. Canal Salut. Consell assessor sobre la diabetis. *Generalitat de Catalunya. Departament de Salut* http://canalsalut.gencat.cat/ca/professionals/participacio/grups_de_treball/consell_assessor_sobre_la_diabetis/ (2015).

19. Departament de Salut. Generalitat de Catalunya. Plà de Salut de Catalunya 2011-2015. *Generalitat de Catalunya. Departament de Salut* http://salutweb.gencat.cat/ca/el_departament/pla_de_salut_2011_2015 (2012, accessed 22 October 2016).

20. Zoungas S, Chalmers J, Ninomiya T, et al. Association of HbA1c levels with vascular complications and death in patients with type 2 diabetes: evidence of glycaemic thresholds. *Diabetologia* 2012; 55: 636–43.

21. Stratton IM. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *B*MJ 2000; 321: 405–412.

22. Ismail-Beigi F, Craven T, Banerji MA, et al. Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: An analysis of the ACCORD randomised trial. *Lancet* 2010; 376: 419–430.

23. Levin SR, Coburn JW, Abraira C, et al. Effect of intensive glycemic control on microalbuminuria in type 2 diabetes. Veterans Affairs Cooperative Study on Glycemic Control and Complications in Type 2 Diabetes Feasibility Trial Investigators. *Diabetes Care* 2000; 23: 1478–85.

24. Gaede P, Vedel P, Parving H-HH, et al. Intensified multifactorial intervention in patients with type 2 diabetes mellitus and microalbuminuria: The Steno type 2 randomised study. *Lancet* 1999; 353: 617–622.

25. Gaede P, Vedel P, Larsen N, et al. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N Engl J Med* 2003; 348: 383–93.

26. Holman RR, Paul SK, Bethel MA, et al. 10-Year Follow-Up of Intensive Glucose Control in Type 2 Diabetes. *N Engl J Med* 2008; 359: 1577–1589.

27. Erdmann E, Harding S, Lam H, et al. Ten-year observational follow-up of PROactive: A randomized cardiovascular outcomes trial evaluating pioglitazone in type 2 diabetes. *Diabetes, Obes Metab* 2016; 18: 266–273.

28. Turner R. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). *Lancet* 1998; 352: 854–865.

29. Zinman B, Wanner C, Lachin JM, et al. Empagliflozin, Cardiovascular Outcomes, and Mortality in Type 2 Diabetes. *N Engl J Med* 2015; 373: 2117–2128.

30. Marso S, Daniels G, Brown-Frandsen K, et al. Liraglutide and Cardiovascular Outcomes in Type 2 Diabetes. *N Engl J Med* 2016; 1–12.

31. Gaede P, Oellgaard J, Carstensen B, et al. Years of life gained by multifactorial intervention in patients with type 2 diabetes mellitus and microalbuminuria: 21 years follow-up on the Steno-2 randomised trial. *Diabetologia* 2016; 59: 1–10.

32. Adler AI, Stratton IM, Neil HA, et al. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): prospective observational study. *BMJ* 2000; 321: 412–9.

33. Grup d'estudi de la diabetis a l'Atenció Primària de Salut (GedapS). *Guia per el tractament de la diabetis tipus 2 a l'Atenció Primària.* 1st ed. Barcelona.: Haymarket, 1993.

34. Cano Pérez JF; Franch Nadal J; y miembros de los grupos de la RedGDPS de España. *Guía de la diabetes tipo 2. Recomendaciones clínicas con niveles de evidencia.* 5th ed. Barcelona: Elsevier España SL., 2011.

35. Mata M, Cos F, Morros R, Diego L, Barrot J, Berengué M et al. Guies de pràctica clínica i material docent, núm. 15. Abordatge de la diabetis mellitus tipus 2. http://www.gencat.cat/ics/professionals/guies/diabetis/diabetis.html (2012, accessed 15 December 2016).

36. American Diabetes Association. 8. Cardiovascular Disease and Risk Management. *Diabetes Care* 2016; 39 Suppl 1: S60-71.

37. RedGDPS. *Práctica clínica en la DM2 Analisis Critico de las evidencias por la redGDPS*. 1st ed. Barcelona, 2011.

38. Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of Hyperglycemia in Type 2 Diabetes, 2015: A Patient-Centered Approach: Update to a position statement of the american diabetes association and the european association for the study of diabetes. *Diabetes Care* 2015; 38: 140–149.

39. American Diabetes Association. Standards of Medical Care in Diabetes-2016 Abridged for Primary Care Providers. *Clin Diabetes* 2016; 34: 3–21.

40. Garber AJ, Abrahamson MJ, Barzilay JI, et al. AACE/ACE Consensus Statement. Consensus Statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the comprehensive Type 2 Diabetes Management Algorithm – 2016 Executive Summary. *Endocr Pract* 2016; 22: 84–113.

41. Alemán JJ, Artola S, Franch J, Mata M, Millaruelo JM y Sangrós J en nombre de la RedGDPS. Recomendaciones para el tratamiento de la diabetes mellitus tipo 2: control glucémico. 2014. http://www.redgdps.org/index.php?idregistro=948 (2014).

42. Cano JF, Baena-Diez JM, Franch J, et al. Long-term cardiovascular risk in type 2 diabetic compared with nondiabetic first acute myocardial infarction patients: a population-based cohort study in southern Europe. *Diabetes Care* 2010; 33: 2004–2009.

43. Mundet X, Cano F, Mata-Cases M, et al. Trends in chronic complications of type 2 diabetic patients from Spanish primary health care centres (GEDAPS study): Ten year-implementation of St. Vincent recommendations. *Prim Care Diabetes* 2012; 6: 11–18.

44. Mata-Cases M, Roura-Olmeda P, Berengué-Iglesias M, et al. Fifteen years of continuous improvement of quality care of type 2 diabetes mellitus in primary care in Catalonia, Spain. *Int J Clin Pract* 2012; 66: 289–298.

45. Franch Nadal J, Artola Menéndez S, Diez Espino J, et al. Evolución de los indicadores de calidad asistencial al diabético tipo 2 en atención primaria (1996-2007). Programa de mejora continua de calidad de la Red de Grupos de Estudio de la Diabetes en Atención Primaria de la Salud. *Med Clin* 2010; 135: 600–607.

46. Bodicoat DH, Mundet X, Davies MJ, et al. The impact of a programme to improve quality of care for people with type 2 diabetes on hard to reach groups: The GEDAPS study. *Prim Care Diabetes* 2015; 9: 211–218.

47. Franch-Nadal J, Roura-Olmeda P, Benito-Badorrey B, et al. Metabolic control and cardiovascular risk factors in type 2 diabetes mellitus patients according to diabetes duration. *Fam Pract* 2015; 32: 27–34.

48. Bodicoat DH, Mundet X, Gray LJ, et al. Identifying effective pathways in a successful continuous quality improvement programme: The GEDAPS study. *J Eval Clin Pract* 2014; 20: 1137–1143.

49. Coll-de-Tuero G, Mata-Cases M, Rodriguez-Poncelas A, et al. Chronic kidney disease in the type 2 diabetic patients: prevalence and associated variables in a random sample of 2642 patients of a Mediterranean area. *BMC Nephrol* 2012; 13: 87.

50. Mata-Cases M, Benito-Badorrey B, Roura-Olmeda P, et al. Clinical inertia in the treatment of hyperglycemia in type 2 diabetes patients in primary care. *Curr Med Res Opin* 2013; 29: 1495–502.

51. Bolíbar B, Fina Avilés F, Morros R, et al. [SIDIAP database: electronic clinical records in primary care as a source of information for epidemiologic research]. *Med Clin* 2012; 138: 617–21.

52. Mata-Cases M, Franch-Nadal J, Mauricio D, et al. Investigar en diabetes desde una base de datos de atención primaria: la experiencia del Sistema de Información para el Desarrollo de la Investigación en Atención Primaria (SIDIAP). *Av Diabetol* 2013; 29: 169–74.

53. Vinagre I, Mata-Cases M, Hermosilla E, et al. Control of glycemia and cardiovascular risk factors in patients with type 2 diabetes in primary care in Catalonia (Spain). *Diabetes Care* 2012; 35: 774–779.

54. Mata-Cases, Manel; Mauricio, Dídac; Vinagre. Irene; Morros, Rosa; Hermosilla, Eduard; Fina, Francesc; Rosell-Murphy, Magdalena; Castell, C; Franch-Nadal, Josep; Bolíbar B. Treatment of Hyperglycaemia in Type 2 Diabetic Patients in a Primary Care Population Database in a Mediterranean Area (Catalonia, Spain). *J Diabetes Metab* 2014; 5: 10.4172/2155-6156.1000338.

55. Mata-Cases M, Mauricio D, Franch-Nadal J. Clinical characteristics of type 2 diabetic patients on basal insulin therapy with adequate fasting glucose control who do not achieve HbA1c targets. *J Diabetes* 2016; 2016: 10.1111/1753-0407.12373 [Epub ahead of print].

56. Ruiz-Tamayo I, Franch-Nadal J, Mata-Cases M, et al. Noninsulin Antidiabetic Drugs for Patients with Type 2 Diabetes Mellitus: Are We Respecting Their Contraindications? *J Diabetes Res* 2016; 2016: 7502489.

57. Franch-Nadal J, Mata-Cases M, Vinagre I, et al. Differences in the cardiometabolic control in type 2 diabetes according to gender and the presence of cardiovascular disease: Results from the econtrol study. *Int J Endocrinol* 2014; 2014: Epub 2014 Sep 21.

58. Barrot-De La Puente J, Mata-Cases M, Franch-Nadal J, et al. Older type 2 diabetic patients are more likely to achieve glycaemic and cardiovascular risk factors targets than younger patients: Analysis of a primary care database. *Int J Clin Pract* 2015; 69: 1486–1495.

59. Mata-Cases M, Franch-Nadal J, Real J, et al. Glycaemic control and antidiabetic treatment trends in primary care centres in patients with type 2 diabetes mellitus during 2007–2013 in Catalonia: a population-based study. *BMJ Open* 2016; 6: e012463.

60. Rodriguez-Poncelas A, Miravet-Jiménez S, Casellas A, et al. Prevalence of diabetic retinopathy in

individuals with type 2 diabetes who had recorded diabetic retinopathy from retinal photographs in Catalonia (Spain). *Br J Ophthalmol* 2015; bjophthalmol-2015-306683.

61. Rodríguez-Poncelas A, Mundet-Tudurí X, Miravet-Jiménez S, et al. Chronic Kidney Disease and Diabetic Retinopathy in Patients with Type 2 Diabetes. *PLoS One* 2016; 11: e0149448.

62. Mata-Cases M, Mauricio D, Real J, et al. Is diabetes mellitus correctly registered and classified in primary care? A population-based study in Catalonia, Spain. *Endocrinol y Nutr* 2016; 63: 440–448.

63. Gervás J, Pérez Fernández M, Starfield BH. Primary care, financing and gatekeeping in western Europe. *Fam Pract* 1994; 11: 307–17.

64. Mata Cases M, Franch Nadal J MD. Evolució de l'atenció a la diabetis tipus 2 a Catalunya 1993-2013. *Diabetis Avui* http://www.acdiabetis.org/d_avui/docs/atencio_catalunya_1993_2013.pdf (2016, accessed 7 October 2016).

65. Bosch R. rba salut i gestió: Les consultes virtuals o e-Consultes. *rba salut i gestió* http://rbasalutigestio.blogspot.com.es/2014/10/les-consultes-virtuals-o-e-consultes.html (2014, accessed 28 October 2016).

66. Sociedad Española de Diabetes http://www.sediabetes.org/ (accessed 28 October 2016).

67. Primary Care Diabetes Europe (PCDE) http://www.pcdeurope.org/ (accessed 28 October 2016).

68. Associació Catalana de Diabetis http://www.acdiabetis.org/ (accessed 28 October 2016).

69. RedGDPS. Programa de mejora de la calidad redGedaps. Evaluación de la atención a la diabetes en atención primaria. http://redgdps.org/index.php?idregistro=259 (2016, accessed 7 November 2016).

70. Institut Català de la Salut http://www.gencat.cat/ics/quees.htm (2016, accessed 7 October 2016).

71. Liebl A, Mata M, Eschwège E. Evaluation of risk factors for development of complications in Type II diabetes in Europe. *Diabetologia* 2002; 45: S23-8.

72. Rothe U, Müller G, Schwarz PE, et al. Evaluation of a diabetes management system based on practice guidelines, integrated care, and continuous quality management in a Federal State of Germany. A population-based approach to health care research. *Diabetes Care* 2008; 31: 863–868.

73. Saaddine JB, Cadwell B, Gregg EW, Engelgau MM, Vinicor F IG, Narayan K. Improvements in Diabetes Processes of Care and Intermediate Outcomes: United States, 1988–2002. *Ann Intern Med* 2006; 144: 465–474.

74. Eliasson B, Cederholm J, Nilsson P, et al. The gap between guidelines and reality: Type 2 diabetes in a national diabetes register 1996-2003. *Diabet Med* 2005; 22: 1420–1426.

75. Cooper JG, Claudi T, Jenum AK, et al. Quality of care for patients with type 2 diabetes in primary care in Norway is improving: results of cross-sectional surveys of 33 general practices in 1995 and 2005. *Diabetes Care* 2009; 32: 81–83.

76. Club Diabete Sicili@. Five-year impact of a continuous quality improvement effort implemented by a network of diabetes outpatient clinics. *Diabetes Care* 2008; 31: 57–62.

77. Campbell SM, Reeves D, Kontopantelis E, et al. Effects of pay for performance on the quality of primary care in England. *N Engl J Med* 2009; 361: 368–378.

78. Casagrande SS, Fradkin JE, Saydah SH, et al. The prevalence of meeting A1C, blood pressure, and LDL goals among people with diabetes, 1988-2010. *Diabetes Care* 2013; 36: 2271–2279.

79. Lipska KJ, Yao X, Herrin J, et al. Trends in Drug Utilization, Glycemic Control, and Rates of Severe Hypoglycemia, 2006–2013. *Diabetes Care* 2016; dc160985.

80. Gunathilake W, Song S, Sridharan S, et al. Cardiovascular and metabolic risk profiles in young and old patients with type 2 diabetes. *QJM* 2010; 103: 881–884.

81. Ödesjö H, Anell A, Gudbjörnsdottir S, et al. Short-term effects of a pay-for-performance programme for diabetes in a primary care setting: an observational study. *Scand J Prim Health Care* 2015; 33: 291–7.

82. van Hateren KJJ, Drion I, Kleefstra N, et al. A prospective observational study of quality of diabetes care in a shared care setting: trends and age differences (ZODIAC-19). *BMJ Open* 2012; 2: e001387.

83. Franch J, Mauricio D, Mata M. Revisió de 20 anys d'atenció a la diabetis a Catalunya. *Monogràfics de la Central de Resultats, número 12. Barcelona: Agència de Qualitat i Avaluació Sanitàries de Catalunya. Departament de Salut. Generalitat de Catalunya* http://observatorisalut.gencat.cat/web/.content/minisite/observatorisalut/ossc_central_resultats/informes/documents/Monografic-Revisio-20-anys-atencio-a-la-diabetis.pdf (2014, accessed 12 October 2016).

84. Fina Avilés, F., Méndez Boo, L., Coma Redon, E., & Medina Peralta M. Sistema de Información de los Servicios de Atención Primaria (SISAP). La experiencia 2006-2009 de l'Institut Català de la Salut. *Rev Innovación Sanit y Atención Integr* 2010; 2: 2.

85. Alonso-Fernández M, Mediavilla-Bravo JJ, López-Simarro F, et al. Evaluation of diabetic foot screening in Primary Care. *Endocrinol Nutr* 2016; 61: 311–7.

86. Tricco AC, Ivers NM, Grimshaw JM, et al. Effectiveness of quality improvement strategies on the management of diabetes: A systematic review and meta-analysis. *Lancet* 2012; 379: 2252–2261.

87. Abu-Qamar MZ. Diabetic foot screening: why is it neglected? *Int Wound J* 2006; 3: 203–13.

88. De Berardis G, Pellegrini F, Franciosi M, et al. Are Type 2 diabetic patients offered adequate foot care? The role of physician and patient characteristics. *J Diabetes Complications* 2005; 19: 319–27.

89. American Diabetes Association. 9. Microvascular Complications and Foot Care. *Diabetes Care* 2016; 39 Suppl 1: S72-80.

90. Stratton IM, Aldington SJ, Taylor DJ, et al. A simple risk stratification for time to development of sight-threatening diabetic retinopathy. *Diabetes Care* 2013; 36: 580–585.

91. Chalk D, Pitt M, Vaidya B, et al. Can the retinal screening interval be safely increased to 2 years for type 2 diabetic patients without retinopathy? *Diabetes Care* 2012; 35: 1663–1668.

92. Kirkman MS, Williams SR, Caffrey HH, et al. Impact of a program to improve adherence to diabetes guidelines by primary care physicians. *Diabetes Care* 2002; 25: 1946–1951.

93. Varroud-Vial M, Mechaly P, Joannidis S, et al. Cooperation between general practitioners and diabetologists and clinical audit improve the management of Type 2 diabetic patients. *Diabetes Metab* 1999; 25: 55–63.

94. Spreeuwenberg C, Eijkelberg IMJG, Wolffenbuttel BHR, et al. Adoption of disease management model for diabetes in region of Maastricht. *BMJ (Clinical Res ed)* 2001; 323: 983–985.

95. Renders CM, Valk GD, Franse L V, et al. Long-term effectiveness of a quality improvement program for patients with type 2 diabetes in general practice. *Diabetes Care* 2001; 24: 1365–1370.

96. Davidson MB, Ansari A, Karlan VJ. Effect of a nurse-directed diabetes disease management program on urgent care/emergency room visits and hospitalizations in a minority population. *Diabetes Care* 2007; 30: 224–227.

97. Peters AL, Davidson MB. Application of a diabetes managed care program: The feasibility of using nurses and a computer system to provide effective care. *Diabetes Care* 1998; 21: 1037–1043.

98. Taylor CB, Miller NH, Reilly KR, et al. Evaluation of a Nurse-Care Management System to Improve Outcomes in Patients With Complicated Diabetes. *Diabetes Care* 2003; 26: 1058–1063.

99. New JP, Mason JM, Freemantle N, et al. Specialist nurse-led intervention to treat and control hypertension and hyperlipidemia in diabetes (SPLINT): a randomized controlled trial. *Diabetes Care* 2003; 26: 2250–5.

100. Renders CM, Valk GD, Griffin SJ, et al. Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. *Diabetes Care* 2001; 24: 1821–33.

101. Shojania KG, Ranji SR, McDonald KM, et al. Effects of quality improvement strategies for type 2 diabetes on glycemic control: A meta-regression analysis. *Jama* 2006; 296: 427–440.

102. Houweling ST, Kleefstra N, Van Hateren KJJ, et al. Can diabetes management be safely transferred to practice nurses in a primary care setting? A randomised controlled trial. *J Clin Nurs* 2011; 20: 1264–1272.

103. Institut Català de la Salut. Manual d'acollida dels nous usuaris dels productes del SISAP: Professionals dels EAP de l'ICS https://si9sapics.files.wordpress.com/2015/12/acollida-sisap_eaps_ics_prof.pdf (2016, accessed 20 October 2016).

104. AQuAS. Agència de Qualitat i Avaluació Sanitàries de Catalunya. Índex de Qualitat de la Prescripció Farmacèutica (IQF) http://catsalut.gencat.cat/web/.content/minisite/catsalut/proveidors_professionals/medicaments_farmacia/catsalut_entitats/IQF-2016.pdf (2016, accessed 17 October 2016).

105. Escalada J, Orozco-Beltran D, Morillas C, et al. Attitudes towards insulin initiation in type 2 diabetes patients among healthcare providers: A survey research. *Diabetes Res Clin Pract* 2016; 122: 46–53.

106. Strain WD, Blüher M, Paldánius P. Clinical Inertia in Individualising Care for Diabetes: Is There Time to do More in Type 2 Diabetes? *Diabetes Ther* 2014; 5: 347–354.

107. Khunti K, Millar-Jones D. Clinical inertia to insulin initiation and intensification in the UK: A focused literature review. *Prim Care Diabetes*. Epub ahead of print 2016. DOI: 10.1016/j.pcd.2016.09.003.

108. Watson L, Das R, Farquhar R, et al. Consequences of delaying treatment intensification in type 2 diabetes: evidence from a UK database. *Curr Med Res Opin* 2016; 32: 1465–1475.

109. Bonafede M, Chandran A, DiMario S, et al. Medication usage, treatment intensification, and medical cost in patients with type 2 diabetes: a retrospective database study. *BMJ Open Diabetes Res Care* 2016; 4: e000189.

110. Levin P, Zhou S, Durden E, et al. Clinical and Economic Outcomes Associated with the Timing of Initiation of Basal Insulin in Patients with Type 2 Diabetes Mellitus Previously Treated with Oral Antidiabetes Drugs. *Clin Ther* 2016; 38: 110–121.

111. Bhattacharya R, Zhou S, Wei W, et al. A real-world study of the effect of timing of insulin initiation on outcomes in older Medicare beneficiaries with type 2 diabetes mellitus. *J Am Geriatr Soc* 2015; 63: 893–901.

112. Bailey CJ, Kodack M. Patient adherence to medication requirements for therapy of type 2 diabetes. *Int J Clin Pract* 2011; 65: 314–322.

113. Mata Cases M. Inercia terapéutica en el control glucémico de la diabetes mellitus tipo 2: Inconvenientes y ventajas. *Hipertens y Riesgo Vasc* 2012; 29: 34–40.

114. López-Simarro F, Brotons C, Moral I, et al. Inercia y cumplimiento terapéutico en pacientes con diabetes mellitus tipo 2 en atención primaria. *Med Clin (Barc)* 2012; 138: 377–384.

115. González-Clemente JM, Font B, Lahoz R, et al. Inercia clínica en pacientes con diabetes mellitus tipo 2 no insulinizados en tratamiento con hipoglucemiantes orales. Estudio INERCIA. *Med Clin (Barc)* 2014; 142: 478–484.

116. Orozco-Beltrán D, Mata-Cases M, Artola S, et al. Abordaje de la adherencia en diabetes mellitus tipo2: situación actual y propuesta de posibles soluciones. *Aten primaria* 2016; 48: 406–420.

117. Brown SA, García AA, Brown A, et al. Biobehavioral determinants of glycemic control in type 2 diabetes: A systematic review and meta-analysis. *Patient Educ Couns* 2016; 99: 1558–67.

118. Bramlage P, Gitt AK, Schneider S, et al. Clinical course and outcomes of type-2 diabetic patients after treatment intensification for insufficient glycaemic control - results of the 2 year prospective DiaRegis follow-up. *BMC Cardiovasc Disord* 2014; 14: 162.

119. Gutiérrez-Fisac JL, Regidor E, Banegas JR, et al. Prevalencia de obesidad en la población adulta española: 14 años de incremento continuado. *Med Clin (Barc)* 2005; 124: 196–197.

120. Aranceta-Bartrina J, Pérez-Rodrigo C, Alberdi-Aresti G, et al. Prevalencia de obesidad general y obesidad abdominal en la población adulta española (25–64 años) 2014–2015: estudio ENPE. *Rev Española Cardiol* 2016; 69: 579–587.

121. Public Health England. *Adult obesity and type 2 diabetes*. 2014. Epub ahead of print 2014. DOI: 2014211.

122. Tiktin M, Celik S, Berard L. Understanding adherence to medications in type 2 diabetes care and clinical trials to overcome barriers: a narrative review. *Curr Med Res Opin* 2015; 7995: 1–11.

123. Sinclair AJ, Paolisso G, Castro M, et al. European Diabetes Working Party for Older People 2011 clinical guidelines for type 2 diabetes mellitus. Executive summary. *Diabetes Metab* 2011; 37 Suppl 3: S27-38.

124. American Diabetes Association. 10. Older Adults. *Diabetes Care* 2015; 38: S67–S69.

125. Regidor E, Franch J, Seguí M, et al. Traditional risk factors alone could not explain the excess mortality in patients with diabetes: A national cohort study of older Spanish adults. *Diabetes Care* 2012; 35: 2503–2509.

126. Baena-Díez JM, Peñafiel J, Subirana I, et al. Risk of Cause-Specific Death in Individuals With Diabetes: A Competing Risks Analysis. *Diabetes Care* 2016; 39: 1987–1995.

127. Abdelhafiz AH, Sinclair AJ. Diabetes in the elderly. *Med (United Kingdom)* 2015; 43: 48–50.

128. Sinclair AJ, Bellary S. Preventing hypoglycaemia: an elusive quest. *lancet Diabetes Endocrinol* 2016; 4: 635–636.

129. Lipska K., Ross J., Miao Y, et al. Potential Overtreatment of Diabetes Mellitus in Older Adults With Tight Glycemic Control. *JAMA Intern Med* 2015; 175: 356–362.

130. Gray A, Raikou M, McGuire A, Fenn P, Stevens R, Cull C, Stratton I, Adler A, Holman R TR. Cost effectiveness of an intensive blood glucose control policy in patients with type 2 diabetes: economic analysis alongside randomised controlled trial (UKPDS 41). United Kingdom Prospective Diabetes Study Group. *BMJ* 2000; 320: 1373–1378.

131. Agència de Qualitat i Avaluació Sanitàries. Pautes per al tractament farmacològic de la diabetis mellitus tipus 2. Barcelona: Agència de Qualitat i Avaluació Sanitàries de Catalunya. Departament de Salut. Generalitat de Catalunya; 2013. (Programa d'Harmonització Farmacoterapèutica de Medicaments enhttp://catsalut.gencat.cat/web/.content/minisite/catsalut/proveidors_professionals/medicaments_farmacia/phf_apc/protocols/diabetis_mellitus_tipus2/pauta_diabetis_01.pdf (2013).

132. Álvarez-García E. HbA1c, estandarización y expresión de resultados. *Endocrinol y Nutr* 2010; 57: 177–181.

133. Ministerio de Sanidad y Consumo, (Estrategia en Diabetes del Sistema Nacional de Salud), Sociedad Española de Diabetes, et al. Recomendaciones sobre armonización de resultados de HbA1c http://www.aebm.org/documentos/Documento estandarizacion HbA1c.pdf (2009, accessed 28 October 2016).

134. Jerant A, Bertakis KD, Franks P. Body mass index and health status in diabetic and non-diabetic individuals. *Nutr Diabetes*; 5. Epub ahead of print 2015. DOI: 10.1038/nutd.2015.2.

135. Hainer V, Aldhoon-Hainerová I. Obesity paradox does exist. *Diabetes Care* 2013; 36 Suppl 2: S276-81.

136. Standl E, Erbach M, Schnell O. Defending the con side: obesity paradox does not exist. *Diabetes Care* 2013; 36 Suppl 2: S282-6.

137. Mancera-Romero J, Hormigo-Pozo A, Fernández-Arquero J, et al. Utilización de fármacos hipoglucemiantes en el ámbito de la atención primaria de Málaga durante los años 2008-2012. *Semergen* 2014; 40: 4–11.

138. Agencia Española de Medicamentos y Productos A. Utilización de medicamentos antidiabéticos en España durante el periodo 2000-2014. *Inf Util Medicam* 2015; 1–8.

139. Rafaniello C, Arcoraci V, Ferrajolo C, et al. Trends in the prescription of antidiabetic medications from 2009 to 2012 in a general practice of Southern Italy: A population-based study. *Diabetes Res Clin Pract* 2015; 108: 157–163.

140. Oishi M, Yamazaki K, Okuguchi F, et al. Changes in oral antidiabetic prescriptions and improved glycemic control during the years 2002-2011 in Japan (JDDM32). *J Diabetes Investig* 2014; 5: 581–587.

141. Kohro T, Yamazaki T, Sato H, et al. Trends in antidiabetic prescription patterns in Japan from 2005 to 2011. *Int Hear J* 2013; 54: 93–97.

142. Torre C, Guerreiro J, de Oliveira Martins S, et al. Patterns of glucose lowering drugs utilization in

Portugal and in the Netherlands. Trends over time. *Prim Care Diabetes* 2015; 9: 482–9.

143. Clemens KK, Shariff S, Liu K, et al. Trends in antihyperglycemic medication prescriptions and hypoglycemia in older adults: 2002-2013. *PLoS One* 2015; 10: 2002–2013.

144. Sharma M, Nazareth I, Petersen I. Trends in incidence, prevalence and prescribing in type 2 diabetes mellitus between 2000 and 2013 in primary care: a retrospective cohort study. *BMJ Open* 2016; 6: e010210.

145. Hampp C, Borders-Hemphill V, Moeny DG, et al. Use of antidiabetic drugs in the U.S., 2003-2012. *Diabetes Care* 2014; 37: 1367–1374.

146. Turner LW, Nartey D, Stafford RS, et al. Ambulatory treatment of type 2 diabetes in the U.S., 1997-2012. *Diabetes Care* 2014; 37: 985–992.

147. Strom H, Selmer R, Birkeland KI, et al. No increase in new users of blood glucose-lowering drugs in Norway 2006-2011: a nationwide prescription database study. *BMC Public Health* 2014; 14: 520.

148. Conthe P, Mata M, Orozco D, et al. Degree of control and delayed intensification of antihyperglycaemic treatment in type 2 diabetes mellitus patients in primary care in Spain. *Diabetes Res Clin Pract* 2011; 91: 108–114.

149. Menéndez Torre E, Lafita Tejedor J, Artola Menéndez S, et al. Documento de Consenso. Recomendaciones para el tratamiento farmacológico de la hiperglucemia en la diabetes tipo 2. *Av en Diabetol* 2010; 26: 331–338.

150. Costi M, Smith H, Reviriego J, et al. Costes directos sanitarios en pacientes con diabetes mellitus tipo 2 a los seis meses de inicio del tratamiento con insulina en España: estudio INSTIGATE. *Endocrinol y Nutr* 2011; 58: 274–282.

151. Orozco-Beltrán D, Artola-Menéndez S. Estudio observacional prospectivo con insulina detemir en pacientes con diabetes mellitus tipo 2 mal controlados que inician por primer vez tratamiento con insulina (estudio SOLVE). *Atención Primaria* 2016; 48: 95–101.

152. Brea A, Laclaustra M, Martorell E, et al. Epidemiología de la enfermedad vascular cerebral en España. *Clínica e Investig en Arterioscler* 2013; 25: 211–217.

153. Ferreira-González I. Epidemiología de la enfermedad coronaria. *Rev Española Cardiol* 2014; 67: 139–144.

154. Bundó M, Aubà J, Vallés R, et al. [Peripheral arteriopathy in type 2 diabetes mellitus]. *Aten primaria* 1998; 22: 5–11.

155. Camafort M. What's new in heart failure in the patient with type 2 diabetes? *Endocrinol y Nutr* 2015; 62: 350–5.

156. Carmona M, García-Olmos LM, Alberquilla A, et al. Heart failure in the family practice: a study of the prevalence and co-morbidity. *Fam Pract* 2011; 28: 128–33.

157. National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Estimating Glomerular Filtration Rate (GFR) | National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) https://www.niddk.nih.gov/health-information/health-communication-programs/nkdep/lab-evaluation/gfr/estimating/Pages/estimating.aspx.

158. Rodriguez-Poncelas A, Garre-Olmo J, Franch-Nadal J, et al. Prevalence of chronic kidney disease

in patients with type 2 diabetes in Spain: PERCEDIME2 study. *BMC Nephrol* 2013; 14: 46.

159. Petersen M. Economic costs of diabetes in the U.S. in 2012. *Diabetes Care* 2016; 39: 1033–1046.

160. Gilmer TP, O'Connor PJ, Rush WA, et al. Predictors of health care costs in adults with diabetes. *Diabetes Care* 2005; 28: 59–64.

161. Alvarsson A, Sandgren B, Wendel C, et al. A retrospective analysis of amputation rates in diabetic patients: can lower extremity amputations be further prevented? *Cardiovasc Diabetol* 2012; 11: 18.

162. Rubio JA, Aragón-Sánchez J, Jiménez S, et al. Reducing major lower extremity amputations after the introduction of a multidisciplinary team for the diabetic foot. *Int J Low Extrem Wounds* 2014; 13: 22–6.

163. Lopez-de-Andres A, Jiménez-García R, Aragón-Sánchez J, et al. National trends in incidence and outcomes in lower extremity amputations in people with and without diabetes in Spain, 2001-2012. *Diabetes Res Clin Pract* 2015; 108: 499–507.

164. Font-Jiménez I, Llaurado-Serra M, Roig-Garcia M, et al. Retrospective study of the evolution of the incidence of non-traumatic lower-extremity amputations (2007-2013) and risk factors of reamputation. *Prim Care Diabetes*. Epub ahead of print 12 May 2016. DOI: 10.1016/j.pcd.2016.04.001.

165. Almaraz MC, González-Romero S, Bravo M, et al. Incidence of lower limb amputations in individuals with and without diabetes mellitus in Andalusia (Spain) from 1998 to 2006. *Diabetes Res Clin Pract* 2012; 95: 399–405.

166. Sender Palacios MJ, Vernet Vernet M, Larrosa Sáez P, et al. Características sociodemográficas y clínicas de una población de pacientes con diabetes mellitus. *Atención Primaria* 2002; 29: 474–480.

167. Kärvestedt L, Mårtensson E, Grill V, et al. Peripheral Sensory Neuropathy Associates With Micro- or Macroangiopathy Results from a population-based study of type 2 diabetic patients in Sweden. *Diabetes Care* 2009; 32: 317–322.

168. Heng LZ, Comyn O, Peto T, et al. Diabetic retinopathy: Pathogenesis, clinical grading, management and future developments. *Diabet Med* 2013; 30: 640–650.

169. Bethel MA, Sloan FA, Belsky D, et al. Longitudinal incidence and prevalence of adverse outcomes of diabetes mellitus in elderly patients. *Arch Intern Med* 2007; 167: 921–7.

170. Svensson MK, Cederholm J, Eliasson B, et al. Albuminuria and renal function as predictors of cardiovascular events and mortality in a general population of patients with type 2 diabetes: a nationwide observational study from the Swedish National Diabetes Register. *Diabetes Vasc Dis Res* 2013; 10: 520–9.

171. Orozco-Beltrán D, Sánchez E, Garrido A, et al. Evolución de la mortalidad por diabetes mellitus en España: análisis del periodo 1998-2013. *Rev Española Cardiol*. Epub ahead of print 2016. DOI: 10.1016/j.recesp.2016.07.007.

172. Brito-Sanfiel M, Diago-Cabezudo J, Calderon a. Economic impact of hypoglycemia on healthcare in Spain. *Expert Rev Pharmacoecon Outcomes Res* 2010; 10: 649–60.

173. Bonds DE, Miller ME, Bergenstal RM, et al. The association between symptomatic, severe hypoglycaemia and mortality in type 2 diabetes: retrospective epidemiological analysis of the ACCORD study. *BMJ* 2010; 340: b4909.

174. Geller AI, Shehab N, Lovegrove MC, et al. National Estimates of Insulin-Related Hypoglycemia and Errors Leading to Emergency Department Visits and Hospitalizations. *JAMA Intern Med* 2014; 174: 678.

175. Kong APS, Yang X, Luk A, et al. Severe hypoglycemia identifies vulnerable patients with type 2 diabetes at risk for premature death and all-site cancer: The Hong Kong Diabetes Registry. *Diabetes Care* 2014; 37: 1024–1031.

176. Davis RE, Morrissey M, Peters JR, et al. Impact of hypoglycaemia on quality of life and productivity in type 1 and type 2 diabetes. *Curr Med Res Opin* 2005; 21: 1477–83.

177. Cryer PE. Minimizing hypoglycemia in diabetes. *Diabetes Care* 2015; 38: 1583–1591.

178. Heller SR, Frier BM, Hersløv ML, et al. Severe hypoglycaemia in adults with insulin-treated diabetes: Impact on healthcare resources. *Diabet Med* 2016; 33: 471–477.

179. Vaghela P, Ashworth M, Schofield P, et al. Population intermediate outcomes of diabetes under pay-for-performance incentives in England from 2004 to 2008. *Diabetes Care* 2009; 32: 427–429.

180. Hassan Sadek N, Sadek AR, Tahir A, et al. Evaluating tools to support a new practical classification of diabetes: Excellent control may represent misdiagnosis and omission from disease registers is associated with worse control. *Int J Clin Pract* 2012; 66: 874–882.

181. Shojania KG, Ranji SR, McDonald KM, et al. Effects of quality improvement strategies for type 2 diabetes on glycemic control: a meta-regression analysis. *J Am Med Assoc* 2006; 296: 427–40.

182. Eijkenaar F, Emmert M, Scheppach M, et al. Effects of pay for performance in health care: a systematic review of systematic reviews. *Health Policy* 2013; 110: 115–30.