UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
FACULDADE DE MEDICINA
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS MÉDICAS:
ENDOCRINOLOGIA

SHEILA PICCOLI GARCIA

Intervenções não farmacológicas para otimização do controle glicêmico de pessoas com diabetes tipo 2: abordagem interdisciplinar

Porto Alegre
2022

Sheila Piccoli Garcia

Intervenções não farmacológicas para otimização do controle glicêmico de pessoas com diabetes tipo 2:
abordagem interdisciplinar

Tese apresentada ao Programa de Pós-graduação em Ciências Médicas: Endocrinologia da Universidade Federal do Rio Grande do Sul como requisito para obtenção do título de Doutor.

Orientadora: Profª Drª Beatriz D'Agord Schaan

Porto Alegre
2022

FICHA CATALOGRÁFICA

GARCIA, Sheila Piccoli
Intervenções não farmacológicas para otimização do controle glicêmico de pessoas com diabetes tipo 2: abordagem interdisciplinar / Sheila Piccoli GARCIA. -- 2022.
138 f.
Orientadora: Beatriz D. Schaan.

Tese (Doutorado) -- Universidade Federal do Rio Grande do Sul, Faculdade de Medicina, Programa de Pós-Graduação em Ciências Médicas: Endocrinologia, Porto Alegre, BR-RS, 2022.

1. Diabetes mellitus tipo 2. 2. Exercício físico. 3. Autocuidado. 4. Educação em Diabetes. I. Schaan, Beatriz D., orient. II. Título.

BANCA EXAMINADORA

Profª Drª Lana Catani Ferreira Pinto

Hospital de Clínicas de Porto Alegre

Universidade Federal do Rio Grande do Sul

Profª Drª Patrícia Martins Bock

Faculdades Integradas de Taquara - FACCAT

Prof. Dr. Rodrigo Sudatti Delevatti

Programa de Pós-graduação em Educação Física

Universidade Federal de Santa Catarina

Profª Drª Luciana Loss Reck Remonti (suplente)

Hospital de Clínicas de Porto Alegre

Universidade Federal do Rio Grande do Sul

AGRADECIMENTOS

Aos integrantes da Liga Interdisciplinar de Diabetes (LIDIA): Mariana, Laura, Leonardo, Karen, Carina, Agnes, Gabriela Berlanda, Felipe, Lucas Porto, Lucas Helal, Aline, Gabriela Teló, que abraçaram a ideia de oferecer um melhor cuidado às pessoas com diabetes tipo 2.

À professora Beatriz pela atenção e presença ao longo dessa jornada. Obrigada por contribuir ativamente com a minha formação acadêmica, servindo de inspiração para vôos maiores.

A minha família, muito obrigada pelo suporte ao longo dos anos. Por entenderem a minha ausência e dedicação. Ao Francisco, pelo companheirismo e carinho.

Ao bebê Lucas – que nasceu durante o desenvolvimento dessa tese – por ressignificar todos os momentos.

“If I have seen further it is by standing on the shoulders of Giants”

- Isaac Newton

Esta Tese de Doutorado segue o formato proposto pelo Programa de Pós-graduação em Ciências Médicas: Endocrinologia, Faculdade de Medicina da Universidade Federal do Rio Grande do Sul, está estruturada da seguinte forma:

1. Introdução
2. Desenvolvimento: artigos originais:
    a. Ensaio Clínico Randomizado: "*Optimization of care for outpatients with type 2 diabetes through the Diabetes Self-Management Multidisciplinary Program: A randomized clinical trial*",
3. Conclusões
4. Anexos
    a. Anexo A – Produção Científica Adicional
    b. Anexo B – Material Suplementar do artigo 1

SUMÁRIO

LISTA DE FIGURAS

LISTA DE TABELAS

LISTA DE ABREVIATURAS E SIGLAS

BMI	*Body Mass Index*
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico
CI	C*onfidence Interval*
CrI	*Credible Interval*
DQOL	*Diabetes Quality of Life*
DSMES	*Diabetes self-management education and support*
FIPE	Fundo de Incentivo à Pesquisa
HCPA	Hospital de Clínicas de Porto Alegre
HIIT	*High-intensity interval training*
IATS	*National Institute of Science and Technology for Health Technology Assessment*
IPAQ	*International Physical Activity Questionnaire*
MP	*Diabetes Self-Management Multidisciplinary Program group*
SDSCA	*Summary of Diabetes Self-Care Activities*
UC	*Usual care group (UC)*
UFRGS	Universidade Federal do Rio Grande do Sul

RESUMO

O diabetes mellitus tipo 2 é uma doença crônica caracterizada por hiperglicemia e é associado com comorbidades vasculares e alta taxa de mortalidade. Por se tratar de uma doença complexa cujo tratamento envolve mudança de estilo de vida é recomendado que o tratamento seja realizado por uma equipe multidisciplinar. Um dos principais objetivos do atendimento da equipe é a educação do paciente para o autocuidado em diabetes, disponibilizando o conhecimento e habilidades necessárias para seu próprio cuidado.

Com a finalidade de melhorar o atendimento criamos e estudamos um programa de autocuidado multidisciplinar (*Multidisciplinar Program*, MP) voltado a pacientes adultos com diabetes tipo 2. O MP constituiu-se de três encontros individuais com enfermeiro, farmacêutico, nutricionista, educador físico e assistente social a fim de receber orientações específicas dos diversos cuidados necessários para melhorar o autocuidado associado ao diabetes. Noventa e seis pacientes foram incluídos no ensaio clínico, randomizados 1:1 para participar do MP ou grupo controle e seguidos por 12 meses. A mudança da hemoglobina glicada em 12 meses não foi diferente entre os grupos, porém, os participantes do MP apresentaram aumento na satisfação e redução na preocupação sobre efeitos futuros do diabetes.

Dentre os tópicos de autocuidado, está a necessidade de prática regular de exercício físico como meio de melhorar o controle glicêmico. Recomenda-se que indivíduos com diabetes tipo 2 realizem pelo menos 150 minutos de exercício aeróbico e mais dois dias de exercício de força por semana. Exercício físico é caracterizado por ser uma atividade física planejada, estruturada, repetitiva, prescrita por profissional de educação física. Entretanto, para uma parcela da população, o exercício físico não é acessível, por isso, o aconselhamento quanto à prática de atividade física por outros profissionais de saúde pode ser benéfica para auxiliar no controle glicêmico. Recentemente, o exercício de alta intensidade intervalado (HIIT, *high-*

intensity interval training) vem sendo estudado e procurado por ser alternativa aos exercícios contínuos. Realizamos uma revisão sistemática com metanálise Bayesiana em rede buscando ensaios clínicos randomizados (ECR) comparando diferentes tipos de exercício físico ou aconselhamento de atividade física em pessoas com diabetes tipo 2. Foram incluídos 113 estudos (13.644 participantes) na metanálise. Em comparação com o grupo controle (sem exercício), todos os tipos de treinamento se associaram com redução de hemoglobina glicada: treinamento aeróbico [-0,60% (95% CrI -0,75; -0,44)], exercício de força [-0,44% (95% CrI -0,68; -0,20)], treinamento combinado [-0,65% (95% CrI -0,85; -0,45)], aconselhamento de atividade física [-0,32% (95% CrI -0,51; -0,12)], e HITT [-0,74% (95% CrI -1,1; -0,34)]. HIIT foi o mais efetivo em reduzir a hemoglobina glicada (SUCRA = 85,5%), no entanto, esse resultado deve ser visto com cautela devido à inclusão de poucos ECRs avaliando esta modalidade.

Os resultados apresentados nessa tese mostram a importância da educação em autocuidado que, apesar de não ter alcançado resultado significativo em reduzir a hemoglobina glicada, foi benéfica em aumentar a qualidade de vida de pessoas com diabetes tipo 2. Além disso, destaca-se a importância de diferentes tipos de exercício físico no controle glicêmico.

Palavras-chave: Diabetes tipo 2; Autocuidado; Equipe Multidisciplinar; Exercício físico; Controle glicêmico

Introdução

O diabetes mellitus tipo 2 é uma doença crônica caracterizada por hiperglicemia devido a defeitos de secreção da insulina e sua ação, bem como falhas na utilização da glicose por tecidos periféricos (1). Mundialmente, estima-se que a prevalência de diabetes seja de 9,3% da população adulta, correspondendo a mais de 463 milhões de pessoas. Esses números estão aumentando em todo o mundo devido à maior expectativa de vida da população em geral, ao crescente número de indivíduos com obesidade e sedentarismo na população. Além disso, a otimização do cuidado às pessoas com diabetes tem contribuído para o aumento da sobrevida, aumentando a prevalência da doença. Projeta-se que, em 2045, o diabetes tipo 2 atinja cerca de 700 milhões de pessoas (2).

A hiperglicemia crônica causa complicações macro e microvasculares ao longo da vida, incluindo cardiopatia isquêmica, retinopatia, doença renal do diabetes, vasculopatia periférica e neuropatia sensitiva e autonômica. Estas complicações crônicas são de alto custo financeiro e social para o indivíduo, sistema de saúde suplementar e público (2). Para ilustrar, no Brasil, 9,3% de todos os custos hospitalares no período de 1999-2001 são atribuíveis ao diabetes (3,4).

É bem demonstrado na literatura que o controle glicêmico adequado é capaz de reduzir a incidência das complicações micro e macrovasculares. Um dos mais importantes estudos publicados sobre o tema, o UKPDS (*United Kingdom Prospective Diabetes Study*), randomizou 4209 pacientes com diagnóstico recente de diabetes para tratamento intensivo (metformina ou insulina ou sulfonilureia, objetivo ter hemoglobina glicada, HbA1c menor do que 7%) ou convencional (primariamente com dieta, objetivo manter HbA1c em níveis convencionais da época, em geral maior do que 8%). Concluiu-se que, no final de 10 anos, houve redução das taxas de retinopatia e doença renal do diabetes nos pacientes do grupo intensivo (HbA1c – média de 7% vs. 7,9% no grupo terapia convencional) (5). Após o encerramento do estudo, todos os pacientes e seus médicos foram aconselhados quanto ao

benefício da redução dos níveis glicêmicos. O seguimento do estudo por 17 anos mostrou manutenção do benefício (menores taxas de infarto do miocárdio, mortes relacionadas ao diabetes e mortes por todas as causas) nos participantes que foram tratados intensivamente no estudo inicial apesar de não haver mais diferença de HbA1c entre os grupos (em torno de 8%) (6).

A publicação deste estudo e outros nas décadas de 1980 a 2000 foi responsável pela alteração de diretrizes de tratamento de pacientes com diabetes tipo 2, recomendando a meta glicêmica de HbA1c abaixo de 7% para adultos (7–9). Entretanto, esta meta deve ser individualizada, sendo menos rígida naqueles pacientes mais idosos ou com menor expectativa de vida, com complicações vasculares estabelecidas ou outras comorbidades importantes.

Não obstante o desenvolvimento de novas classes medicamentosas para o tratamento do diabetes, em uma década (de 1999 a 2010), a taxa de pacientes que atingiram controle glicêmico aumentou em 7,9%. Apesar deste avanço terapêutico, estima-se que 48% encontram-se com HbA1c acima de 8,0% (10). Em países onde o custo do tratamento tem maior peso na escolha dos medicamentos a serem utilizados, o controle glicêmico torna-se mais difícil, sendo que 53% estão com HbA1c acima de 8,0% (11).

Educação para autocuidado em diabetes

Uma das mais importantes mudanças no tratamento do diabetes tipo 2 foi a substituição do tratamento "glicocêntrico" para o conceito de "tratamento centrado no paciente" (12). Além da individualização da meta glicêmica, o médico deve adaptar a escolha medicamentosa e a intensidade da intervenção de acordo com a preferência, necessidade e valores do paciente. Por ser uma doença crônica, complexa, que envolve multissistemas, o cuidado não se restringe apenas à redução da glicemia; faz-se necessário um cuidado mais amplo, com redução de risco

multifatorial (controle pressórico, lipídico, ponderal, cessação de tabagismo, estilo de vida mais saudável, etc) a fim de reduzir a morbimortalidade relacionada à doença.

As instituições relacionadas ao diabetes (13,14) enfatizam que a abordagem seja realizada por uma equipe multiprofissional a fim de possibilitar o melhor cuidado para pessoas com doenças crônicas. Um dos principais objetivos do atendimento da equipe é a educação do paciente para o autocuidado em diabetes (DSME, *diabetes self-management education*), disponibilizando o conhecimento e habilidades necessárias para o autocuidado do paciente e dando autonomia para que este consiga manejar adequadamente o seu tratamento em colaboração com a equipe de saúde (15). Através da educação, o paciente é estimulado a realizar mudança comportamental e escolhas de vida mais saudáveis (alimentação saudável, atividade física regular, etc). Ao aprimorar o conhecimento sobre o diabetes, o paciente é capaz de melhorar desfechos clínicos como reduzir HbA1c, reduzir peso, melhorar a qualidade de vida, e reduzir custos relacionados à saúde (serviços hospitalares) (16).

A equipe multidisciplinar formada por médico, enfermeiro, assistente social, educador físico, fisioterapeuta, nutricionista, farmacêutico deve auxiliar o paciente a seguir padrão saudável de alimentação, perder peso (se tiver obesidade ou sobrepeso), a praticar atividade física pelo menos 150 minutos por semana, de intensidade moderada a intensa, personalizada caso haja alguma limitação (por exemplo, neuropatia periférica) e treinar o paciente a manejar a glicemia peri-exercício. A equipe também deve aconselhar os pacientes a cessar o tabagismo, avaliar imunização anti-influenza e antipneumocócica. A abordagem psicossocial associada à doença e ao tratamento é imprescindível, já que problemas neste âmbito podem prejudicar a adesão ao tratamento.

O autocuidado do diabetes já se mostrou uma excelente opção para o controle glicêmico (17,18) e melhora da qualidade de vida destes pacientes (19). Apesar de existirem diversos formatos de educação em autocuidado, estes devem ser ajustados para a realidade sociocultural

da população de interesse (20). No Brasil, 6,6% da população adulta é considerada analfabeta e 25% apresenta afalfabetismo funcional, portanto, atividades de educação em saúde precisam ser meticulosamente desenvolvidas para atender essa grande parcela da população (21)

Em estudo recente (22), 222 pacientes latinos com diabetes tipo 2 foram randomizados para a) manter tratamento usual, b) participar de programa de educação em autocuidado em diabetes ministrado por agentes comunitários. No final de 6 meses, os indivíduos alocados para o programa de educação apresentaram redução de HbA1c de 0,51% em relação ao basal.

Apesar de importante, promover estratégias de autocuidado ainda é um grande desafio (23,24). Uma metanálise e outra revisão sistemática sobre o assunto demonstram alta heterogeneidade dos estudos, prejudicando a compilação dos resultados. A intervenção pode diferir no tempo de duração e no tempo de interação entre o educador e participante; pode ser administrada de forma presencial ou através do uso de tecnologia (internet, aplicativos, mensagens de celular, etc); pode ser individual, em grupo ou combinada; pode ser administrada por um único profissional da saúde, por líderes comunitários ou uma combinação de educadores. Outro ponto que deve ser levado em conta é o tempo de avaliação dos pacientes após a intervenção: quanto mais próximo do fim do estudo, maior a redução da HbA1c. O benefício glicêmico decai 1 a 3 meses após a interrupção do programa de educação, consistente com outras intervenções comportamentais em diabetes como perda de peso e atividade física (25).

Em uma equipe muldidisciplinar, cada professional tem uma função bem definida. Dentre eles, destaca-se o enfermeiro. Em muitas vezes este profissional exerce o papel de gerente de caso, conhecendo mais a fundo cada paciente com diabetes, suas comorbidades e complicações. Fornece maiores explicações sobre a doença e como o controle glicêmico e de outras comorbidades (hipertensão arterial sistêmica, dislipidemia, obesidade, tabagismo, etc) podem prevenir o surgimento e/ou agravamento de complicações micro e macrovasculares do

diabetes. É responsável pela abordagem do cuidado com os pés, realizando exame físico dos pés e teste de sensibilidade, orientando o paciente sobre a importância de inspeção diária dos pés e medidas de higiene e conforto. Quando da ocorrência de lesões ou úlcera é encarregado da indicação e realização de curativo. Adicionalmente, o enfermeiro também é responsável em conferir a carteira de vacinação, orientar e incentivar a imunização de pessoas com diabetes. É recomendada a aplicação de vacina contra influenza, pneumocócica, hepatite B, *Haemophilus influenza* tipo B, varicela e *Herpes zoster* (26).

O farmacêutico também tem papel importante em melhorar diversos desfechos terapêuticos e aderência ao tratamento. Além de levar educação sobre a doença ao paciente, o farmacêutico intervém clinicamente, auxiliando a efetividade da terapia medicamentosa instituída ao auxiliar no manejo da polifarmácia, modificar horários estabelecidos para tomada de medicamentos. Este profissional tem fundamental papel em melhorar a aderência do tratamento medicamentoso ao orientar ferramentas de apoio como caixa para guardar medicamentos, despertadores para lembrar da medicação, tabelas com horários simplificados. Para pacientes analfabetos ou com dificuldade de compreensão o farmacêutico pode montar uma prescrição pictográfica, utilizando-se de símbolos conhecidos e representações simplificadas, a fim de melhorar sua compreensão e tornar o paciente ativo no seu tratamento (27). Pode-se, por exemplo, utilizar figuras de um sol para indicar os comprimidos a serem tomados pela manhã, e uma lua, para serem tomados à noite.

O tratamento farmacológico é mais complexo em usuários de insulina. Cerca de 30% dos pacientes com diabetes têm ansiedade ou medo de sentir dor ao aplicar insulina (28). Sabe-se que esse medo é associado a piores desfechos como aumento da HbA1c, complicações clínicas e pior estado de saúde geral (29). Medidas como identificar e entender as percepções do paciente, selecionar e orientar o melhor tamanho de agulha para seringa ou caneta aplicadora de insulina, demonstrar a correta técnica de aplicação podem minimizar o medo associado à

aplicação e facilitar a adesão ao tratamento (30). Junto com o enfermeiro, o farmacêutico pode dividir a tarefa de ensinar e aprimorar a aplicação de insulina e manuseio do aparelho monitor de glicose capilar. Mostra os locais e formas do seu armazenamento e descarte adequado de perfurocortantes. Examina o paciente avaliando os locais de aplicação a procura de possíveis complicações cutâneas (31). Além disso, ensina como fazer o teste de glicose capilar e manusear o glicosímetro. Revisão sistemática com metanálise compilando 35 estudos, totalizando 7417 pacientes com diabetes tipo 2 atendidos por farmacêuticos dentro de equipe interprofessional mostrou redução de HbA1c de 0,57% (32).

Ponto chave no tratamento do diabetes tipo 2 é a mudança do estilo de vida, seguindo um padrão alimentar saudável. O nutricionista tem papel fundamental para promover padrões dietéticos que auxiliem no controle glicêmico, na perda e manutenção do peso corporal e redução de fatores de risco cardiovascular. Mais do que indicar dietas, o nutricionista deve individualizar sua orientação baseada em evidências científicas, respeitando seus hábitos, culturas e condições financeiras, construindo dentro das preferências do paciente mudanças saudáveis que possam ser mantidas a longo prazo. Diversas dietas já foram estudadas em populações com diabetes tipo 2 (34). Até o momento, não há um número ideal de calorias ou distribuição dos macronutrientes que deve ser seguida por todos os pacientes. Portanto, deve-se priorizar um padrão alimentar saudável composta de vegetais, frutas, legumes, laticínios, fontes magras de proteína, oleaginosas e grãos integrais. Os seguintes padrões alimentares mostraram benefício em reduzir HbA1c de pacientes com diabetes tipo 2: dieta mediterrânea (35), vegetarianismo ou veganismo (36), baixo em carboidratos (calorias vindas de carboidratos < 26-45% total de calorias), muito baixo em carboidratos (<26% to total de calorias oriundas de carboidratos (37). Em comum, todos priorizam uma alimentação com grãos integrais e vegetais sem amido, minimizando a quantidade de açúcar adicionado e alimento altamente refinado (38).

Além do controle glicêmico, o acompanhamento nutricional tem como finalidade contribuir para a perda (no caso de pessoas com sobrepeso e obesidade) e manutenção (no caso de pessoas eutróficas) do peso corporal. Para tanto, dietas com restrição de calorias planejada para o indivíduo se fazem necessárias e têm maior resultado quando associadas à prática de atividade física. Intervenção de mudança de estilo de vida através de modificações de dieta é capaz de causar uma redução de HbA1c de -0,51% (IC 95% -0,67, -0,35). Esse benefício é mais pronunciado quando associado à perda de peso (redução de 0,8 kg/m^2 no índice de massa corporal), obtendo mudança de hemoglobina glicada de -0,67 (IC 95% -0,85 a -0,49) (39).

É função do assistente social orientar o paciente quanto aos seus direitos, auxiliando quanto à obtenção de medicamentos e insumos relacionados ao tratamento do diabetes. Além disso, deve estimulá-lo a buscar a rede de apoio e participação ativa de seus famíliares no tratamento. As famílias são provedoras de apoio para pacientes com diabetes. Elas auxiliam na organização e manutenção de estrutura para o seguimento do estilo de vida proposto pela equipe multidisciplinar, e também fornecem suporte emocional nos momentos de necessidade (40,41). Divisão de tarefas entre os familiares como compra e preparo dos alimentos, monitorização da glicose, separação e oferecimentos dos medicamentos, agendamento e acompanhamento às consultas e aos exames de sangue reduzem a sobrecarga que a doença traz para os pacientes. Intervenções em que membros da família do paciente com diabetes tipo 2 são incluídos estão associadas à alteração de HbA1c de -0,71% (IC 95% -1,09 to -0,33) (42). Auxiliar o paciente e sua família a construir um relacionamento de apoio entre os membros mostrou-se efetivo em melhorar a adesão à dieta ao longo do período de acompanhamento (43).

Além da complexidade técnica de todo o manejo do seu tratamento, o paciente também enfrenta o custo financeiro e social da sua doença. No Brasil, há diversos programas de saúde para auxiliar o paciente com diabetes, desde consultas individuais ou em grupo na unidade básica de saúde, até programas para liberação de medicamentos orais (metformina,

sulfonilureias), insulinas NPH e regular, além de insumos (seringas, agulhas, fita reagente para aferição da glicose capilar e glicosímetro). Recentemente, foi liberada a dispensação de dapagliflozina para pacientes com diabetes tipo 2, acima dos 65 anos com cardiopatia, aumentando as opções terapêuticas disponibilizadas gratuitamente (33), facilitando a adesão.

Para completar, o educador físico fará a orientação e prescrição sobre a importância do exercício e atividade física para as pessoas com diabetes tipo 2. Inicialmente, deve classificar o grau de atividade física ou sedentarismo. Para aqueles sedentários, a identificação do contexto socioeconômico e de saúde (complicações e comorbidades) faz-se necessário para verificar possíveis barreiras à prática de atividade física e formas de reduzi-las. É papel do educador físico motivar a prática e propor tarefas. Sabe-se que, quando a recomendação de exercício físico é formalizada através de uma prescrição por escrito, aumenta-se a adesão do paciente em relação à prescrição dada de forma oral (44). Nos pacientes que já são ativos, o profissional deve esclarecer informações sobre checagem de glicemia pré e pós treino, ajuste de insulina nos dias de treinamento, necessidade de hidratação, uso de vestuário e calçados adequados. Avaliar a intensidade, frequência e duração do exercício em realização e traçar tarefas específicas para alcançar melhores resultados (45). Para todos os pacientes, a orientação quanto a redução do tempo sedentário é válida. Comportamento sedentário é caracterizado por comportamento com baixo gasto energético como assistir a telas (televisão, celular, *tablet*) ou trabalho sentado, e está associado com pior controle glicêmico e maior risco metabólico. Interromper o tempo sentado com caminhada breve e leve caminhada mostrou-se efetivo em melhorar agudamente o controle glicêmico (46).

Exercício físico no diabetes

Dentre os tópicos de autocuidado, está a necessidade de prática regular de atividade física como meio de facilitar o manejo do controle glicêmico. Considera-se atividade física todo o movimento corporal produzido por contração da musculatura esquelética que aumenta o gasto energético, como por exemplo, limpeza de casa, jardinagem, caminhadas de deslocamento ou no trabalho (45). Já o exercício físico é uma atividade física planejada, estruturada, repetitiva, prescrita por um profissional de educação física, com o objetivo de manter ou melhorar componentes da aptidão física (47).

Tradicionalmente, o exercício físico pode ser do tipo aeróbico ou de força. O exercício aeróbico compreende movimentos coordenados, repetidos de grandes grpos musculares, como por exemplo: caminhar, correr, andar de bicicleta, nadar, etc. O exercício de força é aquele em que o treinamento é realizado contra a resistência como pesos (livres, em aparelhos ou do próprio corpo), faixas elásticas ou molas (45).

Tanto o exercício físico quanto a atividade física devem ser prescritos a todos os pacientes com diabetes pois trazem benefícios além da redução glicêmica; auxiliam na perda de peso, reduzem outros fatores de risco cardiovasculares e melhoram a qualidade de vida (45,48). Sabe-se que o exercício físico é capaz de ativar sinais moleculares contornando a ação defeituosa da insulina nas pessoas com diabetes tipo 2. Esses sinais induzem a translocação do transportador de glicose-4 (GLUT-4) do intracelular para a membrana plasmática. Assim, ocorre o transporte de glicose pelo músculo induzida pelo exercício, contribuindo para a redução da glicemia (49).

Aos pacientes com diabetes tipo 2, recomenda-se a prática de exercício de intensidade moderada a vigorosa na maioria dos dias (sem passar 2 dias sem se exercitar), por pelo menos 150 minutos por semana. Idealmente, deve-se praticar exercícios resistidos (de força) 2 a 3 sessões na semana. Em idosos, exercícios de flexibilidade e equilíbrio são indicados 2 a 3 vezes por semana (13).

Os exercícios estruturados – seja aeróbico, resistido ou combinação destes – tem maior potência no controle glicêmico, com queda da HbA1c de 0,67 (IC 95% -0,84 a -0,49%) (50). Entretanto, como grande parte das pessoas com diabetes não tem acesso à prática de exercício físico regular, o aconselhamento de realizar atividade física é uma saída viável para aumentar a adesão. Quando associado à orientação dietética é possível alcançar redução da HbA1c em 0,58% (IC 95% -0,74 a -0,43%) (50). O exercício intervalado de alta intensidade (HIIT, *high-intensity interval training*) tornou-se uma alternativa para aquelas pessoas que não conseguem praticar a duração recomendada de atividade física devido a restrições de tempo. Recentemente o HIIT também se mostrou efetivo em reduzir HbA1c, índice de massa corporal, além de aumentar a capacidade cardiorespiratória (51).

Desta forma, os objetivos desta tese são: (a) avaliar a efetividade de um programa de autocuidado multidisciplinar voltado a pacientes com diabetes tipo 2 atendidos no Hospital de Clínicas de Porto Alegre; e (b) investigar a efetividade de diferentes tipos de exercícios físicos e aconselhamento em atividade física no controle glicêmico de pessoas com diabetes tipo 2. Para tanto, (a) foi desenhado e conduzido um ensaio clínico randomizado com acompanhamento de 12 meses do Programa de autocuidado em Diabetes; e (b) realizar revisão sistemática com metanálise em rede de ensaios clínicos randomizado comparando diferentes tipos de exercício físico em pessoas com diabetes tipo 2.

REFERÊNCIAS

1. DeFronzo RA. From the Triumvirate to the Ominous Octet: A New Paradigm for the Treatment of Type 2 Diabetes Mellitus. Diabetes [Internet]. 2009 Apr 1;58(4):773–95. Available from: http://diabetes.diabetesjournals.org/cgi/doi/10.2337/db09-9028
2. Internation Diabetes Federation. IDF Diabetes Atlas 9th ed [Internet]. Dunia : IDF. Brussels; 2019 [cited 2020 Oct 1]. 168 p. Available from: www.diabetesatlas.org
3. Rosa RS, Schmidt MI. Diabetes mellitus: magnitude das hospitalizações na rede pública do Brasil, 1999-2001. Epidemiol e Serviços Saúde. 2008;17(2):123–53.
4. Bahia LR, Araujo DV, Schaan BD, Dib SA, Negrato CA, Leão MPS, et al. The Costs of Type 2 Diabetes Mellitus Outpatient Care in the Brazilian Public Health System. Value Heal [Internet]. 2011 Jul;14(5):S137–40. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1098301511014252
5. Turner R. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet. 1998;352(9131):837–53.
6. 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 [Internet]. 2008 Oct 9;359(15):1577–89. Available from: http://www.nejm.org/doi/abs/10.1056/NEJMoa0806470
7. Ismail-Beigi F, Craven T, Banerji MA, Basile J, Calles J, Cohen RM, et al. Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomised trial. Lancet [Internet]. 2010 Aug;376(9739):419–30. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3624763/pdf/nihms412728.pdf

8. The ADVANCE Collaborative Group. Intensive Blood Glucose Control and Vascular Outcomes in Patients with Type 2 Diabetes. N Engl J Med [Internet]. 2008 Jun 12;358(24):2560–72. Available from: http://www.nejm.org/doi/abs/10.1056/NEJMoa0802987

9. Duckworth W, Abraira C, Moritz T. Glucose Control and Vascular Complications in Veterans with Type 2 Diabetes. J Vasc Surg [Internet]. 2009 Apr;49(4):1084. Available from: http://dx.doi.org/10.1016/j.jvs.2009.02.026

10. Ali MK, Bullard KMK, Saaddine JB, Cowie CC, Imperatore G, Gregg EW. Achievement of goals in U.S. diabetes care, 1999-2010. N Engl J Med. 2013;368(17):1613–24.

11. Mendes ABV, Fittipaldi JAS, Neves RCS, Chacra AR, Moreira ED. Prevalence and correlates of inadequate glycaemic control: Results from a nationwide survey in 6,671 adults with diabetes in Brazil. Acta Diabetol. 2010;47(2):137–45.

12. Inzucchi SE, Bergenstal RM, Buse JB, Diamant M, Ferrannini E, Nauck M, 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(1):140–9.

13. Power D. Standards of medical care in diabetes. Diabetes Care [Internet]. 2006 Feb;29(2):476; author reply 476-7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16482699

14. Sociedade Brasileira de Diabetes. Diretrizes da Sociedade Brasileira de Diabetes. São Paulo; 2020.

15. Powers MA, Bardsley JK, Cypress M, Funnell MM, Harms D, Hess-Fischl A, et al. Diabetes Self-management Education and Support in Adults With Type 2 Diabetes: A Consensus Report of the American Diabetes Association, the Association of Diabetes

Care & Education Specialists, the Academy of Nutrition and Dietetics, the American Acad. Diabetes Care [Internet]. 2020 Jul;43(7):1636–49. Available from: http://care.diabetesjournals.org/lookup/doi/10.2337/dci20-0023

16. Beck J, Greenwood DA, Blanton L, Bollinger ST, Butcher MK, Condon JE, et al. 2017 National Standards for Diabetes Self-Management Education and Support. Diabetes Care [Internet]. 2017 Oct;40(10):1409–19. Available from: http://care.diabetesjournals.org/lookup/doi/10.2337/dci17-0025

17. Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. Patient Educ Couns [Internet]. 2016;99(6):926–43. Available from: http://dx.doi.org/10.1016/j.pec.2015.11.003

18. Norris SL, Engelgau MM, Narayan KMV. Effectiveness of self-management training in type 2 diabetes: A systematic review of randomized controlled trials. Diabetes Care. 2001;24(3):561–87.

19. Cochran J, Conn VS. Meta-analysis of Quality of Life Outcomes Following Diabetes Self-management Training. Diabetes Educ [Internet]. 2008 Sep 1;34(5):815–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18832286

20. Ferreira Grillo M de F, Neumann CR, Scain SF, Rozeno RF, Gross JL, Leitão CB. Effect of different types of self-management education in patients with diabetes. Rev da Assoc Médica Bras (English Ed [Internet]. 2013;59(4):400–5. Available from: http://dx.doi.org/10.1016/S2255-4823(13)70494-6

21. Pesquisa Nacional por amostra de domicílios. PNAD Educação 2019: Mais da metade das pessoas de 25 anos ou mais não completaram o ensino médio [Internet]. 2020 [cited 2022 Feb 6]. Available from: https://agenciadenoticias.ibge.gov.br/agencia-sala-de-imprensa/2013-agencia-de-noticias/releases/28285-pnad-educacao-2019-mais-da-

metade-das-pessoas-de-25-anos-ou-mais-nao-completaram-o-ensino-medio

22. Spencer MS, Kieffer EC, Sinco B, Piatt G, Palmisano G, Hawkins J, et al. Outcomes at 18 months from a community health worker and peer leader diabetes self-management program for Latino adults. Diabetes Care. 2018;41(7):1414–22.

23. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-Management Education for Adults With Type 2 Diabetes: A meta-analysis of the effect on glycemic control. Diabetes Care [Internet]. 2002;25(7):1159–71. Available from: http://care.diabetesjournals.org/cgi/doi/10.2337/diacare.25.7.1159

24. Sperl-Hillen J, Beaton S, Fernandes O, Von Worley A, Vazquez-Benitez G, Hanson A, et al. Are benefits from diabetes self-management education sustained? Am J Manag Care [Internet]. 2013 Feb;19(2):104–12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23448107

25. Wing RR, Bolin P, Brancati FL, Bray GA, Clark JM, Coday M, et al. Cardiovascular Effects of Intensive Lifestyle Intervention in Type 2 Diabetes. N Engl J Med [Internet]. 2013;369(2):145–54. Available from: http://www.nejm.org/doi/10.1056/NEJMoa1212914

26. American Diabetes Association. 4. Comprehensive Medical Evaluation and Assessment of Comorbidities: Standards of Medical Care in Diabetes—2022. Diabetes Care [Internet]. 2022 Jan 1;45(Supplement_1):S46–59. Available from: https://diabetesjournals.org/care/article/45/Supplement_1/S46/138926/4-Comprehensive-Medical-Evaluation-and-Assessment

27. Merks P, Cameron J, Bilmin K, Świeczkowski D, Chmielewska-Ignatowicz T, Harężlak T, et al. Medication Adherence and the Role of Pictograms in Medication Counselling of Chronic Patients: a Review. Front Pharmacol [Internet]. 2021 Aug 19;12(August):1–15. Available from:

https://www.frontiersin.org/articles/10.3389/fphar.2021.582200/full

28. Karter AJ, Subramanian U, Saha C, Crosson JC, Parker MM, Swain BE, et al. Barriers to Insulin Initiation. Diabetes Care [Internet]. 2010 Apr 1;33(4):733–5. Available from: https://diabetesjournals.org/care/article/33/4/733/27075/Barriers-to-Insulin-InitiationThe-Translating

29. Fu AZ, Qiu Y, Radican L. Impact of fear of insulin or fear of injection on treatment outcomes of patients with diabetes. Curr Med Res Opin [Internet]. 2009 Jun 1;25(6):1413–20. Available from: https://www.tandfonline.com/doi/full/10.1185/03007990902905724

30. Davida Kruger, LaRue S, Estepa P. Recognition of and steps to mitigate anxiety and fear of pain in injectable diabetes treatment. Diabetes, Metab Syndr Obes Targets Ther [Internet]. 2015 Jan;8:49. Available from: http://www.dovepress.com/recognition-of-and-steps-to-mitigate-anxiety-and-fear-of-pain-in-injec-peer-reviewed-article-DMSO

31. Sociedade Brasileira de Diabetes. Recomendações sobre o tratamento injetável do diabetes: Insulinas e Incretinas. Soc Bras Diabetes. 2017;32.

32. Fazel MT, Bagalagel A, Lee JK, Martin JR, Slack MK. Impact of Diabetes Care by Pharmacists as Part of Health Care Team in Ambulatory Settings: A Systematic Review and Meta-analysis. Ann Pharmacother [Internet]. 2017 Oct 2;51(10):890–907. Available from: http://journals.sagepub.com/doi/10.1177/1060028017711454

33. Ministério da saude; Conitec. Protocolo Clínico e Diretrizes Terapêuticas do Diabete Melito Tipo 2. Vol. 60. 2020.

34. Schwingshackl L, Missbach B, Dias S, König J, Hoffmann G. Impact of different training modalities on glycaemic control and blood lipids in patients with type 2 diabetes: A systematic review and network meta-analysis. Diabetologia. 2014;57(9):1789–97.

35. Esposito K, Ida Maiorino M, Ciotola M, Di Palo C, Scognamiglio P, Gicchino M, et al. Effects of a Mediterranean-Style Diet on the Need for Antihyperglycemic Drug Therapy in Patients With Newly Diagnosed Type 2 Diabetes: A Randomized Trial. Ann Intern Med [Internet]. 2009 Jun;151:306–14. Available from: https://journals.lww.com/00006254-201006000-00017

36. Yokoyama Y, Barnard ND, Levin SM, Watanabe M. Vegetarian diets and glycemic control in diabetes: a systematic review and meta-analysis. Cardiovasc Diagn Ther [Internet]. 2014;4(5):373–82. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25414824%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC4221319

37. Sainsbury E, Kizirian N V, Partridge SR, Gill T, Colagiuri S, Gibson AA. Effect of dietary carbohydrate restriction on glycemic control in adults with diabetes: A systematic review and meta-analysis. Diabetes Res Clin Pract [Internet]. 2018 May;139:239–52. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0168822717311713

38. Evert AB, Dennison M, Gardner CD, Garvey WT, Lau KHK, MacLeod J, et al. Nutrition Therapy for Adults With Diabetes or Prediabetes: A Consensus Report. Diabetes Care [Internet]. 2019 May 1;42(5):731–54. Available from: https://diabetesjournals.org/care/article/42/5/731/40480/Nutrition-Therapy-for-Adults-With-Diabetes-or

39. García-Molina L, Lewis-Mikhael A-M, Riquelme-Gallego B, Cano-Ibáñez N, Oliveras-López M-J, Bueno-Cavanillas A. Improving type 2 diabetes mellitus glycaemic control through lifestyle modification implementing diet intervention: a systematic review and meta-analysis. Eur J Nutr [Internet]. 2020 Jun 28;59(4):1313–28. Available from: https://doi.org/10.1007/s00394-019-02147-6

40. Fisher la W, Chesla CA, Bartz RJ, Gilliss C, Skaff MA, Sabogal F, et al. The Family and Type 2 Diabetes: A Framework for Intervention. Diabetes Educ. 1998;24(5):599–607.

41. Gomes LC, Coelho ACM, Gomides D dos S, Foss-Freitas MC, Foss MC, Pace AE. Contribution of family social support to the metabolic control of people with diabetes mellitus: A randomized controlled clinical trial. Appl Nurs Res [Internet]. 2017 Aug;36:68–76. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0897189716303822

42. Kodama S, Morikawa S, Horikawa C, Ishii D, Fujihara K, Yamamoto M, et al. Effect of family-oriented diabetes programs on glycemic control: A meta-analysis. Fam Pract [Internet]. 2019 Jul 31;36(4):387–94. Available from: https://academic.oup.com/fampra/article/36/4/387/5174885

43. Miller T, DiMatteo R. Importance of family/social support and impact on adherence to diabetic therapy. Diabetes, Metab Syndr Obes Targets Ther [Internet]. 2013 Nov;6:421. Available from: http://www.dovepress.com/importance-of-familysocial-support-and-impact-on-adherence-to-diabetic-peer-reviewed-article-DMSO

44. Swinburn BA, Walter LG, Arroll B, Tilyard MW, Russell DG. The green prescription study: a randomized controlled trial of written exercise advice provided by general practitioners. Am J Public Health [Internet]. 1998 Feb;88(2):288–91. Available from: https://ajph.aphapublications.org/doi/full/10.2105/AJPH.88.2.288

45. Colberg SR, Sigal RJ, Yardley JE, Riddell MC, Dunstan DW, Dempsey PC, et al. Physical activity/exercise and diabetes: A position statement of the American Diabetes Association. Diabetes Care. 2016;39(11):2065–79.

46. Dempsey PC, Larsen RN, Sethi P, Sacre JW, Straznicky NE, Cohen ND, et al. Benefits for Type 2 Diabetes of Interrupting Prolonged Sitting With Brief Bouts of

Light Walking or Simple Resistance Activities. Diabetes Care [Internet]. 2016 Jun 1;39(6):964–72. Available from: https://diabetesjournals.org/care/article/39/6/964/29532/Benefits-for-Type-2-Diabetes-of-Interrupting

47. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep [Internet]. 1985;100(2):126–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/3920711

48. Figueira FR, Umpierre D, Cureau F V., Zucatti ATN, Dalzochio MB, Leitão CB, et al. Association between Physical Activity Advice Only or Structured Exercise Training with Blood Pressure Levels in Patients with Type 2 Diabetes: A Systematic Review and Meta-Analysis. Sport Med. 2014;44(11):1557–72.

49. Stanford KI, Goodyear LJ. Exercise and type 2 diabetes: molecular mechanisms regulating glucose uptake in skeletal muscle. Adv Physiol Educ [Internet]. 2014 Dec;38(4):308–14. Available from: https://www.physiology.org/doi/10.1152/advan.00080.2014

50. Umpierre D, Ribeiro PAB, Kramer CK, Leitão CB, Zucatti ATN, Azevedo MJ, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. Jama. 2011;305(17):1790–9.

51. Liu J, Zhu L, Li P, Li N, Xu Y. Effectiveness of high-intensity interval training on glycemic control and cardiorespiratory fitness in patients with type 2 diabetes: a systematic review and meta-analysis. Aging Clin Exp Res [Internet]. 2019 May 30;31(5):575–93. Available from: http://dx.doi.org/10.1007/s40520-018-1012-z

DESENVOLVIMENTO

a) Artigo 1: *"Optimization of care for outpatients with type 2 diabetes through the Diabetes Self-Management Multidisciplinary Program: A randomized clinical trial."*

(artigo publicado em *Canadian Journal of Diabetes* em 31 de janeiro de 2022, doi 10.1016/j.jcjd.2022.01.006).

ARTIGO 1

"Optimization of care for outpatients with type 2 diabetes through the Diabetes Self-Management Multidisciplinary Program: A randomized clinical trial."

Authors

Sheila P. Garcia[a], Mariana M. Madalosso[b], Leonardo G. Bottino[c], Laura E. R. C. Monteiro[c], Karen Sparrenberger[a], Josiane Schneiders[a], Gabriela Berlanda[a], Carina Blume[a], Agnes N. Gossenheimer[a], Gabriela H. Telo[d,e], Beatriz D. Schaan[f,g]

[a]Postgraduate Program in Endocrinology, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

[b]Nutrition School, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

[c]School of Medicine, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

[d]School of Medicine, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil.

[e]Postgraduate Program in Medicine and Health Sciences, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil.

[f]Endocrine Division, Hospital de Clínicas de Porto Alegre, Porto Alegre, Brazil.

[g]National Institute of Science and Technology for Health Technology Assessment – CNPq, Porto Alegre, Brazil.

Abstract

Objective: To evaluate the efficacy of a Self-Management Multidisciplinary Program (MP) on glycemic control, quality of life and diabetes self-care activities.

Methods: People with type 2 diabetes and A1C > 7.5% were randomized to participate in the MP or to usual care (UC). MP consisted of face-to-face meetings with each health care provider (nurse, pharmacist, dietitian, physical educator and social worker) to approach diabetes self-management issues. MP topics were tailored towards local habits and culture. Three different modules were offered over 12 weeks. The primary outcome was change in A1C from baseline to 12 months. Diabetes Quality of Life and Summary of Diabetes Self-Care Activities questionnaires were assessed at baseline, 6 and 12 months.

Results: Ninety-six participants were included (59 years-old; 60% women; diabetes duration 16 ±10 years; 62% lower middle/low socioeconomic status). Change in A1C at 12 months (UC -0.52% [95% CI -1.08 to 0.26] vs MP -0.30% [95% CI -1.05 to 0.45]; p = 0.072) was not different between the groups. There was an increase in satisfaction and a reduction in worry about future effects of diabetes in the MP group, not found in the UC group.

Conclusions: A short-term self-management multidisciplinary program improved diabetes-related quality of life but failed to reduce A1C in individuals with long-standing type 2 diabetes and a low socioeconomic status.

Trial Registration: ClinicalTrials.gov Identifier: NCT03074383

Keywords: Diabetes mellitus, type 2; Patient Education; Self-care; Self-management; Quality of Life

Introduction

Type 2 diabetes is a chronic disease characterized by hyperglycemia, and is associated with vascular comorbidities and high mortality rate [1]. Despite pharmacological advances over the past two decades [2,3], it is estimated that 33% of people with diabetes have A1C levels above individualized target [4]. Diabetes management goes beyond taking medication. It involves a complex health behavior changes and engagement in routine self-care activities, including food choices, physical activity, blood glucose checks, foot examination, insulin administration, among others. The adoption of these measures associated with the concern about possible complications arising from diabetes results in a daily burden for individuals and their families [5], evidenced by reduced quality of life [6]. For global control of diabetes, individuals need knowledge, training, and support from health care providers to be able to maintain long-term care [7].

Diabetes self-management education and support (DSMES) has proven to be an excellent option for glycemic control and improved quality of life [8,9]. The main goal of diabetes DSMES is to provide knowledge and skills necessary for informed decision making, enhancing individuals autonomy and empowerment [8,10]. There are several forms of DSMES, which must be adjusted to the sociocultural context of the population of interest.

DMSE delivered by a multidisciplinary team were associated with a decrease in glycated hemoglobin when compared with DMSE delivered by a single provider [11,12]. The health care professionals most commonly involved in team-based programs are nurses [13–15], dietitians [13,14] and pharmacists [16]. Others providers (physical educator, social worker, mental health specialists) may also assist the needs of people with diabetes [8,10].

Although important, promoting self-management strategies remains a major challenge [17], especially in low and middle-income countries, where social determinants could impact more strongly on health [18].

The current trial was therefore designed to investigate the effect of a face-to-face short-term self-management multidisciplinary program on glycemic control in outpatients with type 2 diabetes from a public hospital of a middle-income country.

Methods

Study design

This was a single-center, open-label, parallel-group, randomized (1:1) clinical trial, with blinded primary outcome assessors. Individuals aged 18 years or over with type 2 diabetes who were seen at the Diabetes Outpatient Clinic of a tertiary public hospital from Southern Brazil in the previous 12 months were randomly invited to participate in the study by personal or telephone contact. The study was approved by the institution's Research Ethics Committee (protocol no. CAEE 62484316.3.0000.5327), and written informed consent was obtained from each participant prior to enrollment. The trial was registered in ClinicalTrials.gov (NCT03074383) and was reported according to the CONSORT statement [19].

Participants

Eligible participants were all adult individuals aged ≥ 18 years with a diagnosis of diabetes under outpatient follow-up with an endocrinologist in a tertiary hospital and A1C > 7.5% (> 58 mmol/mol). Exclusion criteria were diabetes other than type 2 diabetes, neurological, psychiatric or cognitive deficits that could prevent adequate understanding or participation in the program, and participation in another randomized clinical trial in the last three months.

Interventions

The intervention group participated in the Diabetes Self-Management Multidisciplinary Program (MP), consisting of three face-to-face meetings, with an interval of 4 (± 2) weeks between them. The program consisted of brief individual meetings with health professionals in which different topics were addressed in order to optimize diabetes self-management. At each meeting, the participant was guided through five multidisciplinary stations with the following health care providers: dietitian, nurse, pharmacist, physical educator, and social worker. In each station, the health care provider

individually met with each participant for 15 minutes. Five participants were seen simultaneously within the same room in a rotation system, until all of them inside the room have been seen by all health professionals (Supplementary Methods and Supplementary Figure 1). The topics addressed at each station at each meeting are described in the Supplementary Methods. The health professionals were previously trained, and the Diabetes Self-Management Multidisciplinary Program model was applied in clinic for three months before the start of the trial. Printed educational materials on diabetes (booklet, identification card, and fridge magnet), addressing topics that corresponded to those addressed in the program were provided for all individuals. One coordinator managed the meeting and all professionals gathered together at the end, annotating their assessment and plans on the electronic records.

Participants allocated to the usual care group (UC) met with the research team on three different occasions, with an interval of 4 (±2) weeks between them, to receive the same educational material that the MP group received. These brief (5-10 minutes) meetings were planned as a control for the meetings held by the MP group, as the mere fact of receiving professional attention alone can improve some health outcomes [20]. At the end of the trial, participants in the UC group were invited to participate in the program.

Participants in both groups maintained their routine follow-up visits with their physicians, who were allowed to modify the treatment to achieve the glycemic target if necessary.

The development of the program and the content addressed, both personally and by educational materials, were directed to local culture and habits of the low-income, low-education population. We used simple language in order to motivate engagement in self-care activities in a non-judgmental way. We chose this approach to create a bond of trust with participants in order to empower and help them learn how to manage their own disease. Both the program and meetings were held at the hospital that serves through public health system.

Outcomes

The primary outcome was change in A1C levels from study entry to 12 months. Secondary outcomes were: percentage of participants reaching A1C ≤ 7.5% (58 mmol/mol) and ≤ 8.0% (64 mmol/mol), scores of the following questionnaires: Diabetes Quality of Life (DQOL) [21], Summary

of Diabetes Self-Care Activities (SDSCA) [22], and the International Physical Activity Questionnaire (IPAQ) [23], body weight variation, blood pressure and lipid profile (total cholesterol, HDL cholesterol, and triglycerides). These questionnaires are used in clinical e research settings worldwide and have been cross-culturally adapted and validated for Brazilian Portuguese [24].

DQOL consists of 4 domains (satisfaction, impact, social/vocational worries, and diabetes-related worries) whose answers are scored from 1 to 5. Lower scores indicate higher quality of life. The "social/vocational worries" domain was excluded because most of our participants were retired or inactive.

SDSCA assesses the number of days, over the previous 7 days, on which respondents engaged in several diabetes self-care activities. The closer to 7 days, the better the engagement to self-care items. The revised scoring system was applied by grouping the responses for general diet, foot care, blood glucose testing, and exercise [25].

IPAQ was applied using the following domains: transport-related physical activity, domestic and gardening activities, and leisure time physical activity. Scores were calculated for each domain using the number of minutes of physical activity in the last seven days and the mean number of hours spent sitting per day.

All participants collected blood for A1C, completed the questionnaires and had their weight and blood pressure measured at baseline, 6 and 12 months after study entry. Lipid profile was measured at baseline and at 12 months (Supplementary Figure 2). Socioeconomic status was assessed by the Brazilian Criteria 2015 and Social Class Distribution Update [26].

Randomization

Treatment assignment was determined by computer-generated simple random sequence by a statistical program (SAS software version 9.4) and kept sealed until the participant was allocated to the treatment group. Both investigators who generated and managed randomization list did not participate in the screening or allocation. Due to the nature of the interventions, blinding of the

participants and research staff was not possible. However, the assessor remained blind to participants' treatment allocation.

Statistical analysis

Based in a previous study [27], to detect a difference in A1C values of moderate effect size between the groups, with a power of 80% and a significance level of 0.05, a total sample size of 80 participants was necessary. Given an anticipated drop-out rate of approximately 20%, the recruitment target was increased to 96 participants to compensate for possible losses. Data were expressed as mean ± SD, n (%), or median (interquartile range). For between-group comparisons, Student's *t* test was used for quantitative variables and the chi-square test for categorical variables. Generalized estimating equations for repeated measures analysis with Bonferroni correction were used to assess the effect of the intervention on changes in the primary and secondary outcomes from baseline to 12 months, following the intention-to-treat principle. Primary outcome analyses were adjusted for baseline A1C. All analyses were performed using SPSS software, version 20 (SPSS INC., Chicago, IL, USA).

Results

Participant characteristics

A review of electronic medical records showed that 637 people had been seen at the endocrinology outpatient clinic in the previous year. Of these, 479 were excluded for the following reasons: 359 did not meet the inclusion criteria, 61 did not answer telephone calls, and 11 failed to attend the first visit; 48 were eligible but not contacted (Figure 1). Of the 158 eligible individuals with type 2 diabetes who were successfully contacted, 62 declined to participate in the study, resulting in 96 participants who were randomly assigned to UC (n = 48) or MP (n = 48). Recruitment started in March 2017 and ended in January 2018. Follow-up was completed in March 2019. One participant in

the MP group dropped out of the study shortly after randomization. Four participants died during the study: 3 in the UC group (due to sepsis after cancer surgery, sepsis associated with necrotizing fasciitis, and unknown cause) and 1 in the MP group (stroke); none of the deaths was directly related to the study procedures.

The participants' clinical and laboratory characteristics are shown in Table 1. The sample consisted mostly of women (60%), 59 ± 9 years-old and diabetes duration of 16 ± 10 years. Most participants (62%) belonged to the lower middle socioeconomic class. No differences were observed among groups, except for a non-statistical higher number of women in the UC group.

Attendance rate

High attendance was recorded in the meetings with the research team in the control group (> 93%) and in the MP group (> 95%).

Primary outcome measure

In both groups, A1C at 12 months did not differ from baseline: UC delta (Δ) -0.52% (95% confidence interval [CI] -1.07 to 0.04; p=0.08) *vs.* MP Δ -0.30% (95% CI -1.05 to 0.44; p=1.00), nor between the groups (p=0.33) (Supplementary Table 1 and Supplementary Figure 3). At 6 months, the UC group showed a decrease in A1C [Δ -0.56% (CI -1.04 to -0.08), p=0.02] from baseline, which was not shown at the end of follow-up. At the end of 12 months, only 8 (16.7%) participants in the UC group and 5 (10.4%) in the MP group achieved A1C ≤ 7.5% (58 mmol/mol), p=0.369; 14 (33.3%) participants in the UC group and 10 (21.3%) in the MP group achieved A1C ≤ 8.0% (64 mmol/mol), p=0.203.

Change in weight, blood pressure and lipids

There was no change in weight or blood pressure and no improvement in the lipid profile during follow-up in any of the groups (Supplementary Table 2).

Quality of life

The MP group reported increased satisfaction associated with diabetes (Δ -0.28 [CI -0.55 to -0.02]; p=0.034) and decreased worry about future effects of diabetes (Δ -0.46 [CI -0.79 to -0.12]; p=0.003) 12 months after randomization, a trend not found in the UC group in the same period (Δ -0.12 [CI -0.35 to 0.11]; p=0.64 and Δ 0.09 [CI -0.24 to 0.42]; p=1.0) (Figure 2b and 2c). Overall, there was an improvement in quality of life in the MP group 12 months after randomization: Δ -0.23 (CI -0.45 to -0.01; p=0.04) (Figure 2a). There was no change in scores in the domain of impact associated with diabetes.

Diabetes self-care activities

Among the self-care items assessed by the SDSCA, an improvement was observed in foot care in both groups, evidenced by an increase in the number of days per week on which foot care was performed: from 4.0 days (CI 3.3 to 4.7) at baseline to 4.8 days (CI 4.1 to 5.5) at 12 months (p=0.04) in the UC group, and from 3.8 days (CI 3.1 to 4.5) to 5.1 days (CI 4.4 to 5.8) at 12 months (p<0.001) in the MP group. At baseline, the MP group showed a dietary pattern of less fat consumption than the UC group: 2.3 days (CI 1.5 to 3.0) without consumption of high-fat foods in the UC group *vs.* 3.6 days (CI 3.0 to 4.3) in the MP group (p=0.005) (Table 2). At 6 months, the MP group showed a trend towards a better general dietary pattern in relation to the UC group (4.8 days [CI 4.2 to 5.5] *vs.* 3.7 days [CI 2.8 to 4.6]; p=0.053), but this difference lost significance during follow-up. Both groups reported low engagement in physical activity (UC: 0.9 days [CI 0.4 to 1.3] *vs.* MP: 1.6 days [CI 1.0 to 2.2]; p=0.05 between the groups). Although the MP group performed more time of physical activity at the beginning and 6 months, this difference was not found at the end of the follow-up (p=0.45).

Physical activity

Confirming the findings of the SDSCA questionnaire, both groups had a high rate of physical inactivity. Only 8 (17%) and 18 (38%) participants in the UC and MP groups, respectively, reported exercising for more than 10 minutes continuously during the week (p=0.38). During the 12-month follow-up, the number of minutes of physical activity did not differ from the baseline values (p=1.0 in

both groups), and there was also no difference between the groups (p=0.12). During follow-up, the UC group had higher sedentary time than the MP group at 6 months (8.5 hours per day [CI 7.4 to 9.5] *vs*. 6.6 hours per day [CI 5.3 to 7.8]; p=0.03) and at 12 months (8.9 hours per day [CI 7.6 to 10.2] *vs* .6.30 hours per day [CI 5.2 to 7.4]; p=0.003).

Adverse effects

Participants reported minimal adverse effects related to the study procedures, such as pain or discomfort with blood collection (2 in the MP group and 5 in the UC group) and bruising at the puncture site (4 in the MP group and 7 in the UC group).

Discussion

The Diabetes Self-Management Multidisciplinary Program was developed to provide brief individual assistance for participants with diabetes through a multidisciplinary approach with the objective of improving glycemic control by encouraging diabetes-related self-care activities.

A systematic review comprising 118 randomized clinical trials showed that the reduction in A1c is greater in DSMES interventions performed with a contact time above 10 hours [11]. Although the contact time in our study was around 4 hours, the program design was enough to improve the participants quality of life and foot care.

The reduction in A1C did not reach statistical significance at 12 months from baseline (approximately 9 months after the intervention). This result appears to be consistent with the basic principles of the educational process, in which repetition of information is necessary [28]. Likewise, health behavior changes follow the same pattern, where strengthening of guidance and monitoring by the researchers serve to consolidate the information acquired. Other factors such as high body mass index, presence of comorbidities, low education level, financial distress, and a more negative illness perception are associated with poor activation for behavioral change [29]. It has also been shown that, even when recruiting people who are willing to undergo intensive health behavior changes, intervention effects are lost over time [30].

Unlike previous studies showing improvement in A1C after DSMES interventions [31], our study enrolled individuals seen at a specialized tertiary care outpatient clinic who had long-standing disease and were receiving a complex insulin plan (80% were receiving basal insulin combined with regular insulin), with multiple comorbidities and serious complications associated with diabetes. In a study with an individual approach carried out by a multidisciplinary team, it showed that non-responders were those with poor compliance, serious comorbidities, and limitation of mobility [32]. Other studies that allocated participants with a higher A1C and a higher proportion of insulin users also did not demonstrate maintenance of the glycemic benefit months after the end of the intervention [33,34].

The UC group received printed materials, similar to those of the MP group, addressing the same topics of self-management education, including dietary guidance, importance of physical activity, correct insulin administration. It is possible that following to the recommendations in the printed material and the frequent meetings with the researchers may have contributed to the initial reduction in A1C levels, thus reducing the difference in effect between the groups.

There was no increase in physical activity during follow-up. Due to previously known ischemic comorbidities (39% with coronary artery disease and 13% with stroke) and symptoms compatible with angina reported during participation in the program, the team recommended proper clinical investigation for risk stratification before encouraging physical activity [35]. This may have delayed the start of physical activity and reduced the interest of some participants [36].

Our study has the differential advantage of being a pragmatic randomized clinical trial, with the development of a low-cost multidisciplinary intervention culturally directed to the target population of unmotivated individuals with multiple comorbidities and long-standing diabetes. Because real-life studies include a more representative sample in clinical practice and cause minor changes in the already established routine activities, they represent the real-world efficacy of interventions, producing results that can be more easily applied and generalized [37]. Despite not reaching the primary outcome, the multidisciplinary team decided to maintain the Diabetes Self-Management Multidisciplinary Program for longer time than previously planned after the end of this

trial, because of their personal enthusiasm with the individual results and because participants continued to report they were very grateful for the initiative.

Nevertheless, some limitations need to be addressed. Due to the nature of the proposed intervention, blinding of the participants was not possible. Participants may have informed the attending physician of the intervention, which may have induced the physician not to change doses or include medications in the current treatment plan, thus contributing to treatment inertia. Secondary outcomes were based on data from self-report questionnaires that may suffer from recall bias. Regarding the IPAQ, previous studies have reported a poor association between the questionnaire results and objective data, such as pedometer and accelerometer data [38,39], and a tendency to overestimate the time spent in physical activity [40]. Conversely, another study found no significant difference between self-reported physical activity and that measured by an accelerometer in people with diabetes [41].

Treatment of diabetes is complex and requires engagement in daily tasks. Therefore, self-management of the disease is essential to achieve control and to prevent complications [42]. Short-term interventions have little effect on the achievement of long-term glycemic control [17], and the benefits of the intervention are reduced when measured a few months after its completion [43]. In addition to the benefits achieved, increasing the number of meetings throughout the year could be beneficial to keep individuals motivated and engaged to the recommended care.

Conclusion

In conclusion, a short-term multidisciplinary program was able to improve diabetes-related foot care and quality of life but was insufficient to improve A1C in individuals with long-standing diabetes attended in a public hospital from a medium-income country.

Acknowledgments

The authors would like to thank the participants, their families and all investigators involved in this study.

Author contribution statement

SPG: conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing (original draft, review and editing). MMM and LGB: resources, data curation and writing (review and editing). LERCM, KS, JS, GB, CB and ANG: conceptualization, investigation and writing (review and editing). GHT: conceptualization, methodology, formal analysis, writing (review and editing). BDS: conceptualization, methodology, formal analysis, resources, writing (review and editing), supervision, project administration and funding acquisition.

Author Disclosures

The authors declare that they have no competing interests.

Funding statement

This paper was supported by the Fundo de Incentivo à Pesquisa, Hospital de Clínicas de Porto Alegre (FIPE/HCPA). The study sponsor/funder was not involved in the design of the study; the collection, analysis, and interpretation of data; writing the report; and did not impose any restrictions regarding the publication of the report. LGB received an educational scholarship from the Universidade Federal do Rio Grande do Sul (BIC/UFRGS). MMM received an educational scholarship from the Universidade Federal do Rio Grande do Sul – Pró-Reitoria de Pesquisa (PIBIC/UFRGS). BDS was the recipient of an educational scholarship from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and from the National Institute of Science and Technology for Health Technology Assessment (IATS) – CNPq/Brazil. BDS is a member of the National Institute of Science and Technology for Health Technology Assessment (IATS) – CNPq/Brazil.

References

[1] Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2019;157:107843.

[2] American Diabetes Association. ADA's Timeline [Internet]. ADAs Timeline. [2020 Oct 1].

[3] Chaudhury A, Duvoor C, Reddy Dendi VS, Kraleti S, Chada A, Ravilla R, et al. Clinical Review of Antidiabetic Drugs: Implications for Type 2 Diabetes Mellitus Management. Front Endocrinol (Lausanne). 2017;8(January).

[4] Wang L, Li X, Wang Z, Bancks MP, Carnethon MR, Greenland P, et al. Trends in Prevalence of Diabetes and Control of Risk Factors in Diabetes Among US Adults, 1999-2018. JAMA. 2021;326(8):704–16.

[5] Reusch JEB. The diabetes story: A call to action. Diabetes Care. 2019;42(5):713–7.

[6] Trikkalinou A, Papazafiropoulou AK, Melidonis A. Type 2 diabetes and quality of life. World J Diabetes. 2017;8(4):120.

[7] Frosch DL, Uy V, Ochoa S, Mangione CM. Evaluation of a behavior support intervention for patients with poorly controlled diabetes. Arch Intern Med. 2011;171(22):2011–7.

[8] Powers MA, Bardsley JK, Cypress M, Funnell MM, Harms D, Hess-Fischl A, et al. Diabetes Self-management Education and Support in Adults With Type 2 Diabetes: A Consensus Report of the American Diabetes Association, the Association of Diabetes Care & Education Specialists, the Academy of Nutrition and Dietetics, the American Academy. Diabetes Care. 2020;43(7):1636–49.

[9] Cochran J, Conn VS. Meta-analysis of Quality of Life Outcomes Following Diabetes Self-management Training. Diabetes Educ. 2008;34(5):815–23.

[10] Beck J, Greenwood DA, Blanton L, Bollinger ST, Butcher MK, Condon JE, et al. 2017 National Standards for Diabetes Self-Management Education and Support. Diabetes Care. 2017;40(10):1409–19.

[11] Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. Patient Educ Couns. 2016;99(6):926–43.

[12] Bain SC, Cummings MH, Mckay GA. Multidisciplinary Approach to Management and Care of Patients with Type 2 Diabetes Mellitus. EMJ Diabetes. 2019;7(November):73–81.

[13] Borgermans L, Goderis G, Van Den Broeke C, Verbeke G, Carbonez A, Ivanova A, et al. Interdisciplinary diabetes care teams operating on the interface between primary and specialty care are associated with improved outcomes of care: Findings from the Leuven Diabetes Project. BMC Health Serv Res. 2009;9(May).

[14] Adam L, O'Connor C, Garcia AC. Evaluating the Impact of Diabetes Self-Management Education Methods on Knowledge, Attitudes and Behaviours of Adult Patients With Type 2 Diabetes Mellitus. Can J Diabetes. 2018;42(5):470-477.e2.

[15] Munshi MN, Segal AR, Suhl E, Ryan C, Sternthal A, Giusti J, et al. Assessment of barriers to improve diabetes management in older adults. Diabetes Care. 2013;36(3):543–9.

[16] White RO, DeWalt DA, Malone RM, Osborn CY, Pignone MP, Rothman RL. Leveling the field: addressing health disparities through diabetes disease management. Am J Manag Care. 2010;16(1):42–8.

[17] Norris SL, Engelgau MM, Narayan KMV. Effectiveness of self-management training in type 2 diabetes: A systematic review of randomized controlled trials. Diabetes Care. 2001;24(3):561–87.

[18] Nelson LA, Ackerman MT, Greevy RA, Wallston KA, Mayberry LS. Beyond Race

Disparities: Accounting for Socioeconomic Status in Diabetes Self-Care. Am J Prev Med. 2019;57(1):111–6.

[19] Boutron I, Altman DG, Moher D, Schulz KF, Ravaud P. CONSORT Statement for Randomized Trials of Nonpharmacologic Treatments: A 2017 Update and a CONSORT Extension for Nonpharmacologic Trial Abstracts. Ann Intern Med. 2017;167(1):40.

[20] LaFave SE, Granbom M, Cudjoe TKM, Gottsch A, Shorb G, Szanton SL. Attention control group activities and perceived benefit in a trial of a behavioral intervention for older adults. Res Nurs Health. 2019;42(6):476–82.

[21] Correr CJ, Pontarolo R, Melchiors AC, Rossignoli P, Fernández-Llimós F, Radominski RB. Tradução para o Português e Validação do Instrumento Diabetes Quality of Life Measure (DQOL-Brasil). Arq Bras Endocrinol Metabol. 2008;52(3):515–22.

[22] Michels MJ, Coral MHC, Sakae TM, Damas TB, Furlanetto LM. Questionário de Atividades de Autocuidado com o Diabetes: tradução, adaptação e avaliação das propriedades psicométricas. Arq Bras Endocrinol Metabol. 2010;54(7):644–51.

[23] Matsudo S, Araujo T, Matsudo V, Andrade D, Andrade E, Oliveira LC, et al. Questionário internacional de atividade física (IPAQ): estudo de validade e reprodutibilidade no Brasil. Rev Bras Ativ Fis Saúde. 2001;6(2):5–18.

[24] Bottino LG, Madalosso MM, Garcia SP, Schaan BD, Teló GH. Diabetes-specific questionnaires validated in brazilian portuguese: A systematic review. Arch Endocrinol Metab. 2020;64(2):111–20.

[25] Toobert DJ, Hampson SE, Glasgow RE. The Summary of Diabetes Self-Care. Diabetes Care. 2000;23(7):943–50.

[26] ABEP. Brazilian Criteria 2015 and social class distribution update for 2016. Critério Classif econômica Bras. 2016;1–6.

[27] Polonsky WH, Earles J, Smith S, Pease DJ, Mary M, Christensen R, et al. Integrating medical management with diabetes self-management training. Diabetes Care. 2003;26(11):3048–53.

[28] Pashler H, Rohrer D, Cepeda NJ, Carpenter SK. Enhancing learning and retarding forgetting: Choices and consequences. Psychon Bull Rev. 2007;14(2):187–93.

[29] Bos-Touwen I, Schuurmans M, Monninkhof EM, Korpershoek Y, Spruit-Bentvelzen L, Ertugrul-van der Graaf I, et al. Patient and Disease Characteristics Associated with Activation for Self-Management in Patients with Diabetes, Chronic Obstructive Pulmonary Disease, Chronic Heart Failure and Chronic Renal Disease: A Cross-Sectional Survey Study. PLoS One. 2015;10(5):e0126400.

[30] Wing RR, Bolin P, Brancati FL, Bray GA, Clark JM, Coday M, et al. Cardiovascular Effects of Intensive Lifestyle Intervention in Type 2 Diabetes. N Engl J Med. 2013;369(2):145–54.

[31] Spencer MS, Kieffer EC, Sinco B, Piatt G, Palmisano G, Hawkins J, et al. Outcomes at 18 months from a community health worker and peer leader diabetes self-management program for Latino adults. Diabetes Care. 2018;41(7):1414–22.

[32] Maislos M, Weisman D. Multidisciplinary approach to patients with poorly controlled type 2 diabetes mellitus: A prospective, randomized study. Acta Diabetol. 2004;41(2):44–8.

[33] Fitzpatrick SL, Golden SH, Stewart K, Sutherland J, De Gross S, Brown T, et al. Effect of DECIDE (Decisionmaking Education for Choices in Diabetes Everyday) program delivery modalities on clinical and behavioral outcomes in urban African Americans with type 2 diabetes: A randomized trial. Diabetes Care. 2016;39(12):2149–57.

[34] Sperl-Hillen J, Beaton S, Fernandes O, Von Worley A, Vazquez-Benitez G, Hanson A, et al. Are benefits from diabetes self-management education sustained? Am J Manag Care. 2013;19(2):104–12.

[35] Riebe D, Ehrman J, Liguori G, Magal M. ACSM's Guidelines for Exercise Testing and

Pescription. Tenth edit. Philadelphia, PA; 2018. 651 p.

[36] Franklin BA. Preventing exercise-related cardiovascular events: Is a medical examination more urgent for physical activity or inactivity. Circulation. 2014;129(10):1081–4.

[37] Roland M, Torgerson DJ. Understanding controlled trials. What are pragmatic trials? Br Med J. 1998;316(7127):285–9.

[38] De Cocker KA, De Bourdeaudhuij IM, Cardon GM. What do pedometer counts represent? A comparison between pedometer data and data from four different questionnaires. Public Health Nutr. 2009;12(1):74–81.

[39] Ferrari GL de M, Kovalskys I, Fisberg M, Gómez G, Rigotti A, Sanabria LYC, et al. Comparison of self-report versus accelerometer – measured physical activity and sedentary behaviors and their association with body composition in Latin American countries. PLoS One. 2020;15(4):e0232420.

[40] Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. Int J Behav Nutr Phys Act. 2011;8(1):115.

[41] Mynarski W, Psurek A, Borek Z, Rozpara M, Grabara M, Strojek K. Declared and real physical activity in patients with type 2 diabetes mellitus as assessed by the International Physical Activity Questionnaire and Caltrac accelerometer monitor: A potential tool for physical activity assessment in patients with type 2 dia. Diabetes Res Clin Pract. 2012;98(1):46–50.

[42] Dickinson JK, Maryniuk MD. Building therapeutic relationships: Choosing words that put people first. Clin Diabetes. 2017;35(1):51–4.

[43] Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-Management Education for Adults With Type 2 Diabetes: A meta-analysis of the effect on glycemic control. Diabetes

Care. 2002;25(7):1159–71.

Tables

Table 1. Baseline clinical and laboratorial characteristics

Characteristics	**UC (n = 48)**	**MP (n= 48)**
Age, years	60 ± 9	59 ± 9
Female sex	24 (50)	34 (71)
White race	12 (75)	19 (60)
Education time, year	7 ± 3	7 ± 4
Income ≤ 2 minimum wage	24 (51)	20 (43)
Medium-low/low socio-economic status	30 (63)	30 (63)
Duration of diabetes, years	16 ± 10	16 ± 10
Comorbities – n (%)		
Obesity	32 (67)	32 (67)
Hypertension	43 (92)	46 (96)
Coronary artery disease	28 (58)	18 (39)
Stroke	9 (19)	6 (13)
eGFR <60 mL/min/1.73m^2	16 (33)	10 (21)
Lower limb amputation	2 (4)	3 (6)
SBP, mmHg	140 ± 20	134 ± 19
DBP, mmHg	76 ± 9	78 ± 12
Medication – n (%)		
Metformin	37 (77)	41 (85)
Sulphonylurea	12 (26)	14 (29)
SGLT2 inhibitors	0 (0)	4 (8.3)
Basal insulin [a]	40 (83)	40 (83)
Bolus insulin [b]	19 (40)	19 (40)
Aspirin	33 (69)	28 (58)
Statin	44 (92)	39 (85)
ACE inhibitors/ARBs	43 (90)	40 (85)
Laboratory tests		
A1C, %	9.5 ± 1.2	9.9 ± 1.5
A1C, mmol/mol	80 ± 13	84 ± 15
Total cholesterol, mg/dL	171 ± 45	169 ± 43
HDL-c, mg/dL	43 ± 13	45 ± 13
LDL-c, mg/dL	93 ± 42	89 ± 35
Triglycerides, mg/dL	180 ± 83	195 ± 86

Data are presented as median ± SD or n (%).
ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; DBP, diastolic blood pressure; eGFR, estimated glomerular filtration rate; MP, Multidisciplinary Program group; SBP, systolic blood pressure; SGLT2, sodium-glucose co-transporter-2; UC, usual care.

[a] Three participants (two in usual care and one in MP group) were in use of insulin glargine. The others were using NPH insulin.
[b] One participant in intervention group were in use of insulin lispro. The others were using regular insulin.

Table 2. Change in self-care activities at 6 and 12 months from baseline

		Usual Care Group				Multidisciplinary Program Group				
		Mean (SE)	**Δ**	**95% CI**	**p value [a]**	**Mean (SE)**	**Δ**	**95% CI**	**p value [a]**	**p value [b]**
General diet [c]	Baseline	3.89 (0.4)	--	--	--	4.39 (0.4)	--	--	--	0.34
	6 mo.	3.70 (0.5)	-0.19	-1.32 to 0.95	1.0	4.84 (0.4)	0.45	-0.30 to 1.19	0.44	0.05
	12 mo.	3.75 (0.4)	-0.13	-1.19 to 0.93	1.0	4.25 (0.4)	-0.14	-0.96 to 0.68	1.0	0.35
Eat high-fat	Baseline	2.25 (0.4)	--	--	--	3.64 (0.3)	--	--	--	<0.01
food [d]	6 mo.	2.09 (0.4)	-0.16	-1.23 to 0.92	1.0	3.78 (0.4)	0.14	-0.97 to 1.26	1.0	<0.01
	12 mo.	2.02 (0.4)	-0.23	-1.32 to 0.86	1.0	3.38 (0.4)	-0.26	-1.20 to 0.68	1.0	0.02*
Fruit and	Baseline	2.31 (0.4)	--	--	--	2.88 (0.4)	--	--	--	0.35
vegetable	6 mo.	2.94 (0.6)	0.63	-0.76 to 2.02	0.83	3.48 (0.5)	0.60	-0.99 to 2.19	1.0	0.49
intake [e]	12 mo.	1.96 (0.4)	-0.35	-1.52 to 0.82	1.0	2.76 (0.5)	-0.12	-1.55 to 1.31	1.0	0.22
Blood	Baseline	3.30 (0.4)	--	--	--	3.84 (0.5)	--	--	--	0.38
glucose	6 mo.	3.38 (0.5)	0.08	-1.06 to 1.23	1.0	3.46 (0.6)	-0.39	-1.60 to 0.83	1.0	0.92
testing [f]	12 mo.	2.76 (0.5)	-0.54	-1.53 to 0.46	0.59	3.65 (0.4)	-0.19	-1.35 to 0.96	1.0	0.17
Physical	Baseline	0.86 (0.2)	--	--	--	1.63 (0.3)	--	--	--	0.05

Activity [g]	6 mo.	1.36 (0.4)	0.50	-0.45 to 1.45	0.62	2.54 (0.3)	0.91	-0.08 to 1.90	0.08	0.02
	12 mo.	1.30 (0.3)	0.44	-0.34 to 1.21	0.53	1.63 (0.3)	0.0	-0.97 to 0.97	1.0	0.45
Foot care [h]	Baseline	4.02 (0.4)	--	--	--	3.79 (0.4)	--	--	--	0.64
	6 mo.	4.06 (0.4)	0.04	-1.10 to 1.17	1.0	5.29 (0.3)	1.51	0.62 to 2.39	<0.01	0.02
	12 mo.	4.80 (0.4)	0.78	0.02 to 1.54	0.04	5.10 (0.4)	1.31	0.43 to 2.19	<0.01	0.55

Data presented as mean (SE), delta and 95% confidence interval, in an intention-to-treat analysis. Mo, months.
[a], within group difference from baseline to 6 and 12 months; [b], between-group difference in each time period.

Summary of Diabetes Self-Care Activities Questionnaire (SDSCA) questions asked:
[c] "On how many of the last seven days have you followed a healthy diet for diabetes?" and "... have you followed an eating plan for diabetes?"
[d] "On how many of the last seven days did NOT you eat high-fat foods such as red meat or full-fat dairy products?"
[e] "On how many of the last seven days did you eat five or more servings of fruits and vegetables?"
[f] "On how many of the last seven days did you test your blood sugar?" and "…did you test your blood sugar the number of times recommended by your health care provider?"
[g] "On how many of the last seven days did you participate in at least 30 minutes of physical activity?" and "… did you participate in a specific exercise session (such as swimming, walking, biking)?"
[h] "On how many of the last seven days did you check your feet?" and "…did you inspect the inside of your shoes?

Figures

Figure 1. Participant flow diagram during the 12-month period.

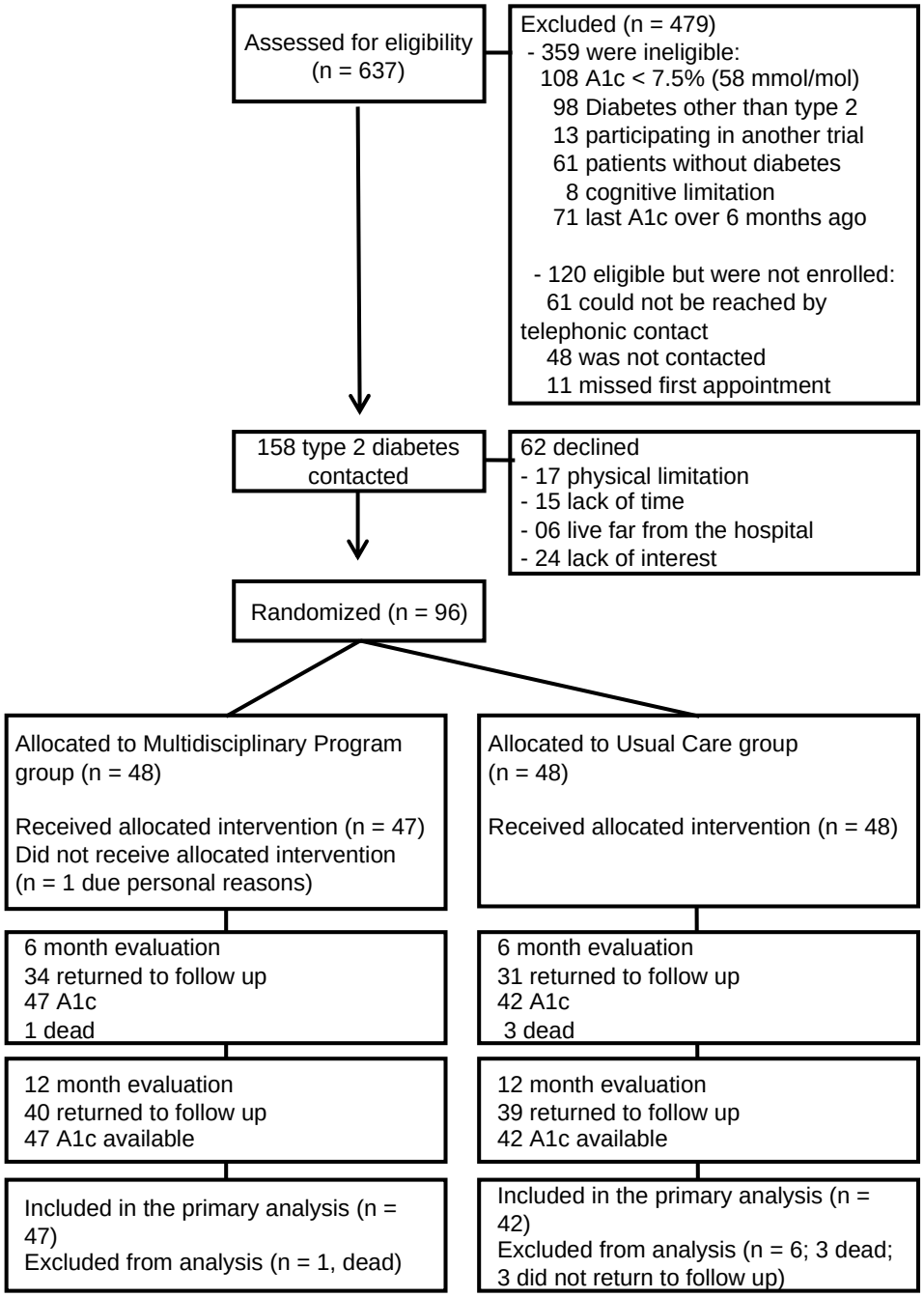
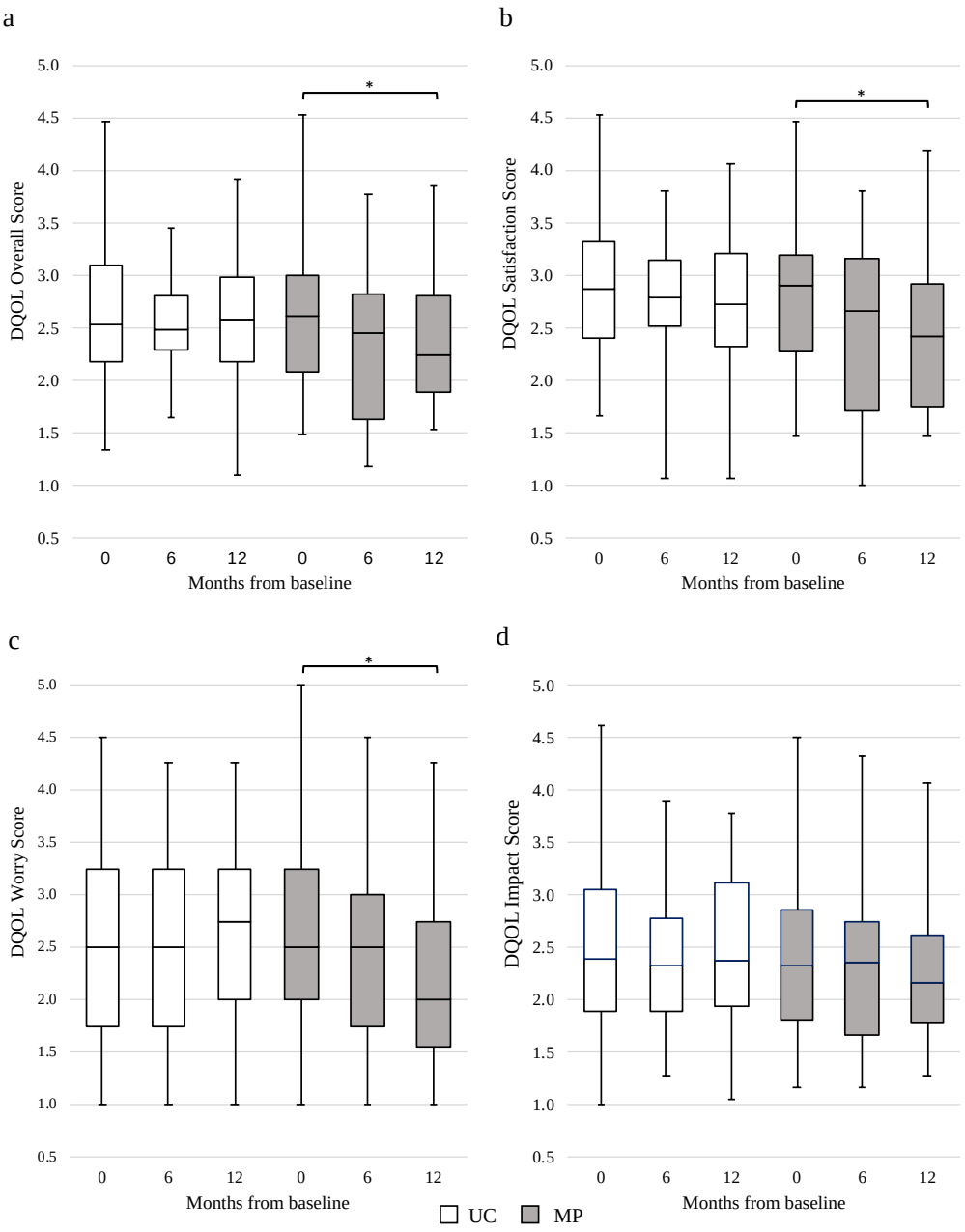


Figure 2. Diabetes Quality of Life Questionnaire (DQOL) score change 6 and 12 months from baseline.

DQOL scores range from 1 to 5. Higher value means poorer quality of life in each separate domain and overall score. There was a significant improvement in the overall quality of life (a), satisfaction (b) and worry (c) about future effects of diabetes domains in the MP group after 12 months, not found in UC group. There was no change in the impact (d) domain. MP, multidisciplinary program; UC, usual care. *, $p<0.05$.



ANEXO A – PRODUÇÃO CIENTÍFICA ADICIONAL

Além dos artigos apresentados, foram desenvolvidos os seguintes trabalhos durante o período do doutorado:

- Capítulo de livro:

Schneiders J, Schneider SMB, Garcia SP. Neuropatia diabética e pé diabético. *In:* Gossenheimer AN, Schaan BD, Teló GH (org.). Diabetes melito: uma visão interdisciplinar. 1. Ed. Porto Alegre: Pubblicato Editora, 2021 p. 55-63

- Artigo completo:

Bottino LG, Madalosso MM, Garcia SP, Schaan BD, Teló GH. Diabetes-Specific Questionnaires Validated in Brazilian Portuguese: A Systematic Review. Archives of Endocrinology and Metabolism. 2020 Mar 27;64:111-20.

Monteiro LERC, Garcia SP, Bottino LG, Custodio JL, Teló GH, Schaan BD. Precipitating factors of diabetic ketoacidosis in type 1 diabetes patients at a tertiary hospital: a cross-sectional study with two-period comparison. Archives of Endocrinology and Metabolism. 2022.

ANEXO B – MATERIAL SUPLEMENTAR DO ARTIGO 1

Supplementary material

Optimization of care for outpatients with type 2 diabetes through the Diabetes Self-Management Multidisciplinary Program: A randomized clinical trial

Supplementary Methods

At each meeting, participant was guided through five multidisciplinary stations with the following health care providers: dietitian, nurse, pharmacist, physical educator, and social worker. In each station, the health care provider individually met with each participant for 15 minutes. Five participants were seen simultaneously within the same room in a rotation system, until all of them inside the room have been seen by all health professionals (Supplementary Figure 1). The health professionals were previously trained, and the MP model was applied in clinic for three months before the start of the trial.

Topics addressed at each station:

In Module 1, the following topics were addressed:

- **Pharmacist Station:** Medication management, with tips to improve adherence to medication and insulin use. For individuals using insulin, assessment of insulin administration sites and techniques, storage, possible skin complications, and proper disposal of sharps. Explanation about hypoglycemia (its identification and treatment).

- **Nurse Station**: Explanation about the definition of diabetes and microvascular and macrovascular complications, including how glycemic control and control of other comorbidities (hypertension, dyslipidemia, obesity, smoking) can prevent them. Evaluation of continuous foot care (importance of prevention and self-care through simple hygiene and comfort measures). Performing the monofilament test.

- **Dietitian Station**: Structured history taking to identify the individual's dietary and nutritional profile and guidance on glycemic index.

- **Physical Educator Station:** Building up a profile of the individual in relation to physical activity/exercise, within 3 possible levels: does not exercise; seeks to exercise, but without any guidance; and exercises formally, under guidance. Then, participants receive the most appropriate recommendations for their possible profile and are encouraged to modify their behavior towards a more active profile. Identification of possible barriers to physical activity, clarifying the reasons why increased physical activity is important for treatment and establishing objective tasks for the

next meetings. Participants already aware of the importance of physical activity/exercise who make an effort to perform them but still do not have professional guidance will receive a brief guidance on care before, during, and after exercise, as well as the indication of places where exercise-based health interventions are provided free of charge.

- **Social Worker Station:** Identification of the individual's profile through a questionnaire for personal identification, family support, and socioeconomic context. If no participant family member is present, a reflection will be initiated on the importance of family support throughout the treatment and an invitation will be made for a family member to attend Module 2.

Once all meetings have been held, the participant received a fridge magnet and a folder with foot care and other self-care activities instructions.

Module 2 is an active listening module, saving more time to answer participants' questions and to reinforce the content delivered in Module 1. In each station, health professionals start by asking participants what they have learned in Module 1 and what changes they were able to make after the meeting. Positive reinforcement is given for each action taken by the participant, who will be encouraged to take further actions not yet fully explored.

- **Nurse Station**: Practical evaluation of insulin self-administration and correct handling of the blood glucose monitor, including notes for capillary blood glucose monitoring.

- **Pharmacist Station**: Development of a medication schedule chart for better understanding and adherence.

- **Dietitian Station:** Approach to the treatment of hypoglycemia (indicated and contraindicated foods), how to read labels of processed foods and how to identify unprocessed, minimally processed, and ultra-processed foods.

- **Physical Educator Station:** Checking the effectiveness of previous counseling. If it is clear that no action has been taken by the participant to change the pattern of physical activity, the focus should be shifted to reinforcing previous counseling, re-identifying possible barriers, and outlining new tasks based on the demands raised. If an increase in physical activity is identified, it

is positively reinforced in relation to the behavioral change. Participants then receive guidance for the next level of exercise according to their profile, as previously identified.

- **Social Worker Station:** To verify if the social difficulties for continuity of treatment remain the same or if there have been changes mainly regarding access to medications, family support, and community support. If a family member is present, a specific approach will be taken in order to identify participation in the participant's treatment and other options for family support, such as more effective attendance at consultations, treatment monitoring (particularly in relation to medications), and emotional support.

In Module 3, previous guidance provided to participant is reinforced and refined:

- **Nurse Station**: Reinforcement of the importance of preventing microvascular and macrovascular complications resulting from uncontrolled diabetes. Explanation about the importance of assessing nephropathy, retinopathy, and heart disease. Guidance to help participants understand the usual monitoring of diabetes and the proper completion of the participant's card in future clinical appointments.

- **Pharmacist Station:** Handling of insulin, syringes, glucometer, reagent strips, and lancets under the supervision of the pharmacist.

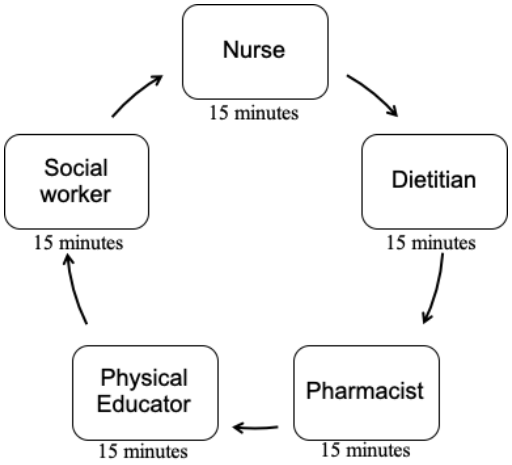
- **Dietitian Station:** Guidance on sweeteners (main types and daily amount recommended) and eating out of home (suggestions for better food choices and options when participants need to eat in restaurants, snack bars, parties, and social events).

- **Physical Educator Station:** The health professional follows the counseling structure used in the previous modules, seeking to evaluate the effectiveness of the alternative strategies addressed in the second visit. If failures are detected in adherence to the specific measure, the measure is re-addressed, and its importance is emphasized. If the participant already shows an improved behavior, guidance focus on the importance of maintaining this status. Approaches to help overcome barriers related to adherence to higher levels of physical activity and exercise is based on the implementation intention strategy. This strategy aims at building action plans in the form

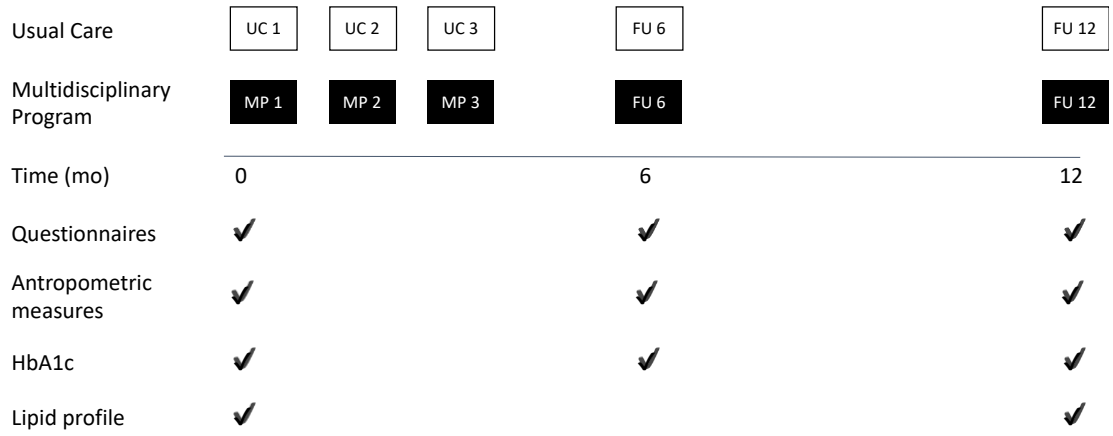
of an “if-then plan”, and it has been shown to be very efficient in health-related behavior modification.

- **Social Worker Station:** Encouraging family participation and support network, encouraging interaction with other person with diabetes, assessing attendance to medical appointments, and providing assistance and guidance on how to obtain medications and supplies necessary for the treatment of diabetes.

Supplementary Figure 1. Participant care flowchart for the Diabetes Self-Management Multidisciplinary Program modules. After a meeting with the researchers, each participant was seen individually by each of the 5 health professionals. After a 15-minute session in the first station, the participant moved to the next station to receive information from the next health professional, and so on until all 5 stations have been covered.

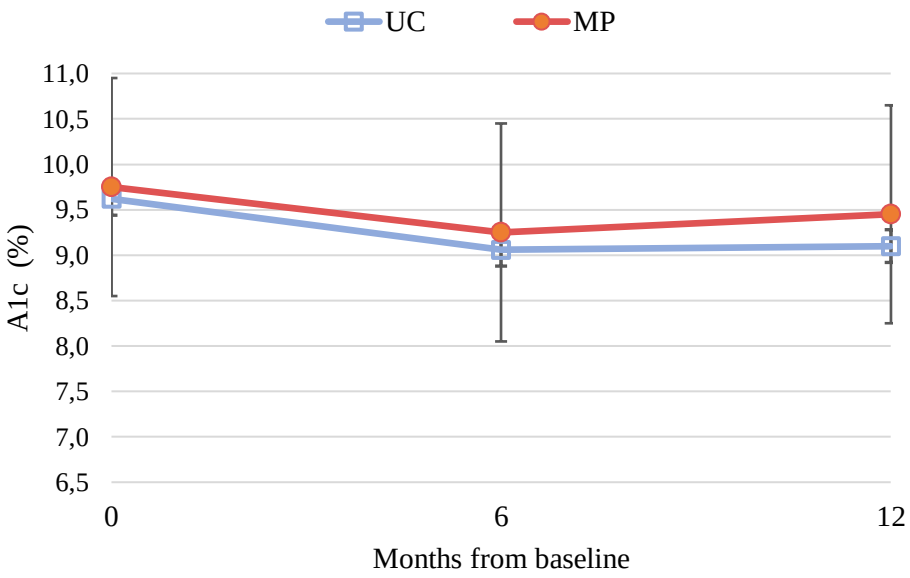


Supplementary Figure 2. Assessments performed during follow-up. Participants in the usual care (UC) group met with the research team to receive printed material, whereas the participants in the Multidisciplinary Program (MP) group met with health professionals on 3 different occasions, with an interval of 4 weeks between them. Afterwards, they returned to attend follow-up (FU) visits at 6 and 12 months for questionnaire completion, anthropometric measurements, and blood collection. Mo, months



Supplementary Figure 3. Change in A1C 6 and 12 months from baseline.

Data present in mean (SE) by visit during the 12-month period. MP, multidisciplinary program; UC, usual care.



Supplementary Table 1. Changes in glycated hemoglobin at 6 and 12 months from baseline

	Usual Care Group				Multidisciplinary Program Group				
A1c, %	**Mean (SE)**	**Δ**	**95% CI**	**p value †**	**Mean (SE)**	**Δ**	**95% CI**	**p value †**	**p value ‡**
Baseline	9.62 (1.2)				9.74 (1.1)				0.31
6 months	9.06 (1.3)	-0.56	-1.04 to -0.08	0.02	9.24 (1.2)	-0.50	-1.10 to 0.10	0.14	0.52
12 months	9.10 (1.3)	-0.52	-1.07 to 0.04	0.08	9.44 (1.3)	-0.30	-1.05 to 0.44	1.00	0.33

Data presented as mean (SE), delta and 95% confidence interval, in an intention-to-treat analysis, adjusted for baseline A1c.

†, within group A1c difference from baseline to 6 and 12 months; ‡, between-group A1c difference in each time period.

Supplementary Table 2. Change in lipid profile, blood pressure and body mass index at 6 and 12 months from baseline

		Usual Care Group				Multidisciplinary Program Group				
		Mean (SE)	**Δ**	**95% CI**	**p value †**	**Mean (SE)**	**Δ**	**95% CI**	**p value †**	**p value ‡**
Total Cholesterol, mg/dL	**Baseline**	170.7 (6.5)				166.0 (6.0)				0.61
	12 months	172.2 (5.7)	1.5	-8.5 to 11.5	0.76	163.2 (4.8)	-2.8	-12.3 to 6.6	0.56	0.24
HDL-c, mg/dL	**Baseline**	42.5 (1.8)				42.6 (2.0)				0.98
	12 months	42.9 (1.9)	0.4	-1.5 to 2.1	0.73	42.8 (2.0)	0.2	-2.1 to 1.7	0.87	0.97
LDL-c, mg/dL	**Baseline**	93.1 (6.3)				87.4 (5.0)				0.49
	12 months	93.5 (5.3)	0.4	-9.4 to 10.1	0.94	83.0 (4.9)	-4.4	-13.1 to 4.3	0.32	0.15
Triglycerides, mg/dL	**Baseline**	180.0 (12.4)				195.7 (13.7)				0.39
	12 months	179.7 (12.1)	-0.3	-19.4 to 18.7	0.97	187.9 (15.6)	-7.8	-27.3 to 11.7	0.43	0.67
Systolic Blood Pressure, mmHg	**Baseline**	140.0 (3.0)				134.3 (2.7)				0.17
	6 months	135.7 (3.0)	-4.3	-9.4 to 0.7	0.12	134.6 (2.8)	0.3	-4.7 to 5.3	1.0	0.79
	12 months	137.5 (3.4)	-2.5	-8.7 to 3.7	1.0	131.3 (2.9)	-2.9	-9.3 to 3.4	0.80	0.19

Diastolic Blood Pressure, mmHg	**Baseline**	76.3 (1.3)				78.3 (1.7)				0.38
	6 months	74.4 (1.5)	-1.9	-4.3 to 0.4	0.16	77.9 (1.8)	-0.3	-2.8 to 2.1	1.0	0.13
	12 months	75.1 (1.5)	-1.2	-4.5 to 2.0	1.0	76.4 (1.7)	-1.9	-5.2 to 1.3	0.48	0.58
BMI, kg/m^2	**Baseline**	32.9 (0.8)				33.7 (1.0)				0.54
	6 months	32.9 (0.8)	0.0	-0.5 to 0.4	1.0	34.3 (1.0)	0.6	-0.3 to 1.4	0.29	0.29
	12 months	32.8 (0.8)	-0.1	-0.6 to 0.3	1.0	34.0 (1.0)	0.3	-0.2 to 0.8	0.34	0.34

Data presented as mean (SE), delta and 95% confidence interval, in an intention-to-treat analysis.

†, within group difference from baseline to 6 and 12 months; ‡, between-group difference in each time period.

BMI: body mass index.