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Fatores associados à aptidão cardiorrespiratória de crianças e adolescentes portadores de Diabetes Mellitus Tipo 1: uma revisão de escopo

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Dissertação apresentada ao Programa de Pós-Graduação em Ciências Aplicadas à Saúde, da Universidade Federal de Juiz de Fora, Campus Governador Valadares, como requisito parcial à obtenção do título de Mestre em Ciências Aplicadas à Saúde, área de concentração Biociências.

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"A educação é a arma mais poderosa que você pode usar para mudar o mundo."

(Nelson Mandela)

RESUMO

O Diabetes Mellitus Tipo 1 (DM1) é uma doença autoimune que destrói as células beta do pâncreas, resultando em produção insuficiente de insulina. Evidências científicas apontam que crianças e adolescentes com DM1 apresentam menor aptidão cardiorrespiratória (AC) em comparação aos seus pares sem a doença. No entanto, os fatores que contribuem para essa redução da capacidade aeróbica ainda não estão completamente elucidados. Diante disto, foi conduzida uma revisão de escopo com o objetivo de identificar os fatores que influenciam a AC de crianças e adolescentes portadores de DM1. Para tal, foram adotadas as diretrizes e recomendações do "*JBI Manual for Evidence Synthesis" e* PRISMA-ScR. As bases de dados PubMed, Cochrane Library, Web of Science, Embase, LILACS, SCOPUS e SPORTDiscus foram utilizadas para as pesquisas. Na literatura cinzenta foram consideradas as bases Biblioteca Digital de Teses e Dissertações da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), ProQuest e Clinical Trials, sem restrições de data e idioma. A estratégia de busca nas bases de dados utilizou termos MeSH e DeCS: *"Child", "Adolescent", "Diabetes Mellitus, Type 1"* e *"Cardiorespiratory Fitness"*. A estratégia PCC (População, Conceito e Contexto) foi utilizada, sendo: P - indivíduos de 2 a 18 anos com diagnóstico de DM1; C - qualquer fator que influencie a AC e C - AC, e com base nessas definições foi estabelecida a pergunta norteadora: "Quais os fatores que influenciam a AC de crianças e adolescentes portadores de DM1"? A seleção e extração dos estudos foi realizada por dois revisores independentes, com apoio de um terceiro revisor em caso de discordâncias. A busca nas bases de dados resultou em 844 estudos, dos quais foram incluídos 27 estudos publicados entre 1993 e 2024, sendo a maioria oriunda do continente americano. Quanto ao delineamento metodológico, a predominância foi de estudos observacionais. A amostra total envolveu 2.346 participantes, sendo 1.736 com DM1. O teste cardiopulmonar foi o método mais utilizado para mensuração da AC. Os principais fatores associados à AC foram fisiológicos e bioquímicos, com destaque para a hemoglobina glicada (HbA1c), que foi avaliada e 26 (96,30%) estudos, seguida pelo índice de massa corporal (n= 18; 66,67%), nível de atividade física (n= 10; 37,04%), gordura corporal, perfil lipídico (n=7; 25,93%) tempo de diagnóstico da doença, idade e sexo (n= 6; 22,22%) pressão arterial (n = 3; 11,11%) e função vascular (n= 2; 7,41%). A HbA1c apresentou associação negativa em 48,1% dos estudos. Adicionalmente, o perfil lipídico e a gordura corporal apresentaram associações predominantemente negativas com a AC, enquanto os níveis de atividade física foram associados positivamente. Não

foram encontrados dados sobre fatores comportamentais. Apesar da maioria dos estudos sugerirem associação entre melhor controle glicêmico e maior AC, os resultados foram heterogêneos. Em contrapartida, a prática regular de atividade física mostrou-se associada positivamente a melhores níveis de AC. Conclui-se que o bom controle glicêmico e a prática de atividade física associam-se a melhores níveis de AC, e que a AC pode ser um marcador relevante da saúde cardiometabólica em crianças e adolescentes com DM1, contribuindo no monitoramento e prevenção de complicações metabólicas e cardiovasculares nessa população.

Palavras-chave: Composição Corporal. Consumo de Oxigênio. Controle Glicêmico. Teste de Caminhada. Teste de Esforço.

ABSTRACT

Type 1 Diabetes Mellitus (T1DM) is an autoimmune disease that destroys the beta cells of the pancreas, resulting in insufficient insulin production. Scientific evidence shows that children and adolescents with T1DM have lower cardiorespiratory fitness (CRF) compared to their peers without the disease. However, the factors that contribute to this reduction in aerobic capacity have not yet been fully elucidated. In view of this, a scoping review was conducted with the aim of identifying the factors that influence the CRF of children and adolescents with T1DM. To this end, the guidelines and recommendations of the "JBI Manual for Evidence Synthesis" and PRISMA-ScR were adopted. The PubMed, Cochrane Library, Web of Science, Embase, LILACS, SCOPUS and SPORTDiscus databases were used for the searches. The gray literature databases were the Digital Library of Theses and Dissertations of the Coordination for the Improvement of Higher Education Personnel (CAPES), ProQuest and Clinical Trials, with no date or language restrictions. The search strategy in the databases used MeSH and DeCS terms: "Child", 'Adolescent', "Diabetes Mellitus, Type 1" and "Cardiorespiratory Fitness". The PCC (Population, Concept and Context) strategy was used: P - individuals aged 2 to 18 diagnosed with T1DM; C - any factor influencing CRF and C - CRF, and based on these definitions the guiding question was established: "What factors influence CRF in children and adolescents with T1DM"? The selection and extraction of studies was carried out by two independent reviewers, with the support of a third reviewer in the event of disagreements. The search in the databases resulted in 844 studies, of which 27 studies published between 1993 and 2024 were included, the majority from the American continent. As for the methodological design, observational studies predominated. The total sample involved 2,346 participants, 1,736 of whom had T1DM. The cardiopulmonary test was the most commonly used method for measuring CRF. The main factors associated with CRF were physiological and biochemical, particularly glycated hemoglobin (HbA1c), which was assessed in 26 (96.30%) studies, followed by body mass index (n= 18; 66.67%), level of physical activity (n= 10; 37.04%), body fat, lipid profile (n=7; 25.93%) time since diagnosis of the disease, age and gender (n= 6; 22.22%) blood pressure (n = 3; 11.11%) and vascular function (n= 2; 7.41%). HbA1c showed an inverse association in 48.1% of the studies. In addition, lipid profile and body fat showed predominantly negative associations with CRF, while physical activity levels were positively associated. No data was found on behavioral factors. Although most studies suggest an association between better glycemic control and higher CRF, the results were

heterogeneous. On the other hand, regular physical activity was positively associated with better levels of CRF. We conclude that good glycemic control and physical activity are associated with better levels of CRF and that CRF can be a relevant marker of cardiometabolic health in children and adolescents with T1DM, contributing to the monitoring and prevention of metabolic and cardiovascular complications in this population.

Keywords: Body Composition. Oxygen Consumption. Glycemic Control. Walk Test. Exercise Test.

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1 INTRODUÇÃO

1.1 Diabetes *mellitus*

O diabetes *mellitus* é caracterizado por um conjunto de distúrbios metabólicos relacionados ao metabolismo de carboidratos, nos quais a glicose é subutilizada como fonte de energia e superproduzida devido à gliconeogênese e glicogenólise inadequadas, resultando em hiperglicemia (Sacks *et al.*, 2023). Globalmente, estima-se que, aproximadamente, 537 milhões de adultos vivam com diabetes, e esse número deve chegar a 643 milhões até 2030 e 783 milhões até 2045. O envelhecimento populacional e a urbanização são considerados os principais fatores desencadeadores para o aumento destes números (Magliano e Boyko, 2021).

No Brasil, os dados seguem a tendência mundial. A prevalência de diabetes aumenta progressivamente com a idade, iniciando em 0,5% entre 18 e 24 anos, progredindo para 2,4% entre 25 e 34 anos, 5,5% entre 35 e 44 anos, 10,4% entre 45 e 54 anos, 22,4% entre 55 e 64 anos e atingindo 30,3% em indivíduos com 65 anos ou mais (Brasil, 2023).

O diagnóstico do diabetes pode ser feito com base nas concentrações aumentadas de glicose plasmática ou aumento do nível de hemoglobina glicada no sangue. Os sintomas mais comuns dessa doença são a poliúria, polidipsia, perda de peso inexplicável, e crises hiperglicêmicas (ADA, 2025).

O descontrole glicêmico do diabetes, a longo prazo, pode ocasionar diversas complicações em diferentes órgãos, como olhos, rins, nervos, coração e vasos sanguíneos (ADA, 2014). Contudo, a adoção de tratamento não farmacológico e farmacológico podem retardar ou evitar complicações inerentes a esta condição de saúde (Magliano e Boyko, 2021). Isto é possível por meio de educação sobre diabetes, estímulo ao autocuidado, orientação nutricional, prática de exercício físico, monitoramento regular da glicemia e a inserção da farmacoterapia de antidiabéticos, incluindo antidiabéticos oral e o uso de insulina (ADA, 2019).

A Sociedade Brasileira de Diabetes orienta a classificação baseada na etiopatogenia do diabetes, dividindo-o em: diabetes *mellitus* tipo 1 (DM1), diabetes *mellitus* tipo 2, além de outras classificações menos frequentes, como o diabetes gestacional e outros tipos de diabetes (Rodacki *et al.*, 2022).

1.2 Diabetes *mellitus* tipo 1

O DM1 corresponde a cerca de 5% a 10% dos casos de diabetes (Saeedi *et al.*, 2019), e sua incidência tem aumentado mundialmente, com crescimento anual de 3%, afetando aproximadamente uma em cada 400 a 600 crianças e adolescentes (Magliano e Boyko, 2021). Tal crescente pode ser explicada, pelo menos em parte, por modificações recentes nos fatores ambientais e no estilo de vida desta população, como o excesso de peso, deficiências nutricionais e estresse (Infante *et al.*, 2019; Rewers e Ludvigsson, 2016).

Ainda que a doença possa se desenvolver em qualquer idade, ela é diagnosticada com mais frequência na população infantojuvenil (Magliano e Boyko, 2021). E, embora haja uma taxa constante de novos casos ao longo da vida adulta, o primeiro pico de incidência ocorre entre 10 e 14 anos de idade (Gregory *et al.*, 2022).

Neste cenário, segundo a Federação Internacional de Diabetes, o Brasil ocupa o sexto lugar no mundo entre os países com mais pessoas com diabetes e o terceiro lugar quando se refere ao DM1 (Magliano e Boyko, 2021).

Como o DM1 é uma doença autoimune multifatorial que apresenta deficiência grave de insulina devido à destruição das células beta pancreáticas, existe a necessidade de insulinoterapia desde o início do diagnóstico (Rodacki *et al.*, 2024). Ainda, devido sua complexidade, a doença exige cuidados de saúde contínuos ao longo da vida (ADA, 2022).

1.2.1 Insulinoterapia no DM1

O tratamento com insulina deve ser iniciado logo após o diagnóstico clínico, a fim de prevenir a descompensação metabólica e a cetoacidose diabética (Júnior *et al.*, 2023). O esquema de insulinoterapia deve ser individualizado, de acordo com a disponibilidade de insulinas, assim como fatores como a idade, a massa corporal, o estágio puberal, o estilo de vida, a rotina diária, o tempo diagnóstico do diabetes, a condição do local de aplicação de insulina, o nível de atividade física e os hábitos alimentares de cada indivíduo (Danne *et al.*, 2018).

O uso da insulina, pode ser realizado com múltiplas doses de insulina, ou com infusão contínua de insulina (bomba de insulina). As insulinas exógenas podem ser classificadas conforme a duração da sua ação ou início de sua atividade. De forma

simplificada, elas podem ser categorizadas como: (1) insulinas de ação ultrarrápida; (2) insulinas de ação rápida; (3) insulinas de ação intermediária; (4) insulinas de ação prolongada; e (5) insulinas de ação ultralonga (Elsayed *et al.*, 2023).

1.2.2 Controle glicêmico no DM1

O controle glicêmico em pessoas com diabetes tem alto valor preditivo para possíveis complicações da doença. Atualmente, a hemoglobina glicada é um dos principais testes para avaliar esse desfecho. Este exame laboratorial reflete a média dos níveis de glicose sanguínea nos últimos 2 a 3 meses, e com isso, o controle glicêmico a longo prazo (ADA, 2022a). A recomendação é que crianças e adolescentes mantenham a hemoglobina glicada abaixo de 7%, a depender das características de cada indivíduo (ADA, 2022b). Alcançar tal recomendação demonstrou redução na mortalidade por todas as causas, doenças cardiovasculares (DCV) e complicações microvasculares em grandes estudos epidemiológicos (UKPDS Group, 1998; Nathan *et al.*, 1993; Nathan *et al.*, 2014).

Nesta perspectiva, o controle glicêmico é um fator importante no avanço da doença e, quando realizado de forma inadequada, pode resultar em diversas complicações (ADA, 2022a). Nesses casos, tanto os episódios de hiperglicemia quanto de hipoglicemia, característicos do DM1, podem levar à disfunção cardíaca a longo prazo, o que pode aumentar a taxa de mortalidade cardiovascular (Rao *et al.*, 2011; Sarwar *et al.*, 2010).

O controle glicêmico eficaz pode prevenir risco de DCV, uma vez que, no DM1, cada incremento de 1% acima de 7% na HbA1c está associado ao aumento de 30% no risco de insuficiência cardíaca (Lind *et al.*, 2011).

1.2.3 Risco de doença cardiovascular e DM1

O DM1 está associado a risco aumentado de DCV em comparação com indivíduos sem a doença, e pode reduzir a expectativa de vida em até 13 anos (Meijs *et al.*, 2010). A prevalência de eventos cardiovasculares graves entre indivíduos portadores de DM1 pode ser até 30 vezes maior do que em pessoas saudáveis. Além disso, crianças com DM1 apresentam maior risco de desenvolver DCV em comparação com crianças sem a doença (Miculis *et al.*, 2012). Porém, a etiologia e os mecanismos que promovem a ocorrência das doenças cardíacas em indivíduos com DM1 não estão totalmente elucidados (Eckstein *et al.*, 2021).

A atividade física insuficiente está fortemente relacionada à mortalidade por todas as causas e por DCV no Brasil e no mundo (Ding, 2018; Guthold *et al.*, 2018). Tanto em estratégia individual, quanto populacional de prevenção de DCV, é essencial priorizar o incentivo à um estilo de vida mais ativo (Arem *et al.*, 2015; Saint-Maurice *et al.*, 2019).

Nesse sentido, o exercício físico regular desempenha um papel importante na prevenção de DCV associada ao diabetes, contribuindo para a melhoria da saúde geral e do bem-estar (Tilden, Noser e Jaser, 2023; Wu *et al.*, 2019).

1.3 Exercício físico e DM1

A prática regular de exercício físico é importante para o tratamento do DM1 e consequente prevenção de suas complicações crônicas (Aljawarneh *et al.*, 2019). Embora a prática regular de atividade física seja recomendada para um bom controle do diabetes (Codella, Terruzzi e Luzi, 2017; Riddell *et al.*, 2017), as taxas de inatividade física ainda são altas nessa população (Plotnikoff *et al.*, 2006). A baixa capacidade funcional e o desequilíbrio glicêmico durante/após os exercícios são frequentemente apontados como obstáculos para o início ou manutenção da atividade física regular (Brazeau, 2008; Codella, Terruzzi e Luzi, 2017; Plotnikoff *et al.*, 2006; Riddell *et al.*, 2017).

A Sociedade Brasileira de Diabetes recomenda que pessoas com DM1 realizem, no mínimo, 150 minutos semanais de exercício aeróbico de moderada ou vigorosa intensidade, não permanecendo mais do que dois dias consecutivos sem exercício físico. Além disso, na prescrição do exercício físico, é fundamental considerar o risco cardiovascular e a intensidade do exercício (Pereira *et al*., 2023).

1.3.1 Exercício físico e DM1 em crianças e adolescentes

Em crianças e adolescentes com DM1, recomenda-se a realização de exercícios físicos diariamente, durante 60 minutos, de intensidade moderada a vigorosa (Adolfsson *et al.*, 2022). Essa prática deve ser integrada à rotina dos jovens como parte do tratamento, visto que o exercício físico tem demonstrado benefícios significativos na melhoria da aptidão cardiorrespiratória, na redução dos fatores de risco cardiovascular e na promoção da qualidade de vida dessa população (Absil *et al.*, 2019; Colberg *et al.*, 2016; Kennedy *et al.*, 2013; Wu *et al.*, 2021). No entanto, os benefícios clínicos do exercício sobre os desfechos fisiológicos e bioquímicos em jovens com DM1 têm se mostrado inconsistentes

(García-Hermoso *et al.*, 2023), especialmente no que se refere ao exercício como um fator contribuidor para o controle glicêmico (Kennedy *et al.*, 2013; Ostman *et al.*, 2018; Quirk *et al.*, 2014).

Adolescentes com alto nível de atividade física (Ekelund *et al.*, 2012; Hay *et al.*, 2012) e aptidão cardiorrespiratória (AC) elevada (Hurtig-Wennlöf *et al.*, 2007; Mcgavock *et al.*, 2009) possuem menor chance de desenvolver comorbidades relacionadas a DCV na idade adulta, assim como menores níveis de pressão arterial e redução na incidência da obesidade. Nesse contexto, a prática regular de exercício físico (Van Sluijs *et al.*, 2021) e o aumento da AC (Raghuveer *et al.*, 2020) são fundamentais para promoção de saúde de crianças e adolescentes, incluindo aqueles com diabetes (Adolfsson *et al.*, 2022; Maahs *et al.*, 2014).

1.4 Aptidão cardiorrespiratória

Define-se como AC, a capacidade dos sistemas circulatório e respiratório de fornecer oxigênio às mitocôndrias do músculo esquelético, visando suprir a energia necessária durante a atividade física (Ross *et al.*, 2016). Uma baixa AC é um forte preditor, independente de DCV, de mortalidade por outras causas na população adulta em geral (Ross *et al.*, 2016).

O principal índice para avaliar a capacidade aeróbica é o consumo máximo de oxigênio ($VO_{2máx}$) (Stringer, 2010). O $VO_{2máx}$ refere-se ao maior valor alcançado, mesmo com o aumento progressivo da carga aplicada, com o surgimento de um platô na curva do consumo de oxigênio em teste de exercício incremental (Herdy *et al.*, 2023). Como os jovens não costumam atingir o platô durante o exercício incremental, o maior $VO_{2máx}$ medido nessa população, é denominado VO_{2pico} (Plowman e Meredith, 2013; Takken *et al.*, 2019).

Alcançar o $VO_{2máx}$ exige a integração de altos níveis das funções pulmonares, cardiovasculares e neuromusculares, sendo um marcador universal capaz de refletir amplamente a gravidade da doença em pacientes portadores de doenças cardiopulmonares, bem como indicador do nível de condicionamento físico (Guazzi *et al.*, 2012; Meneghelo *et al.*, 2010; Sorajja *et al.*, 2012). O $VO_{2máx}$ também é considerado um bom preditor de sobrevida em longo prazo, superando qualquer outro fator de risco tradicional ou parâmetro fisiológico medido (Leeper *et al.*, 2013).

O $VO_{2máx}$ pode ser determinado por teste de esforço, em esteira ou cicloergômetro, pela análise de gases (ergoespirometria). Este método é considerado padrão-ouro na avaliação funcional cardiorrespiratória, e na maioria dos protocolos, o teste consiste em aumentos progressivos na intensidade do esforço até a exaustão (Herdy *et al.*, 2023).

A aplicação deste teste exige profissionais capacitados, apresenta um custo elevado, e pode ser de difícil replicação em crianças. Contudo, uma alternativa para estimar o $VO_{2máx}$ são os testes submáximos. Estes testes são geralmente baseados em atividades físicas submáximas, caminhas e/ou corridas, em que se utiliza a relação entre a distância percorrida e variáveis como frequência cardíaca, velocidade ou potência, para estimar o $VO_{2máx}$, através de equações (Solway *et al*., 2001).

1.4.1 Aptidão cardiorrespiratória em crianças e adolescentes

Em jovens, a AC pode predizer vários indicadores de saúde, incluindo a saúde cardiometabólica (Lang *et al.*, 2018; Ruiz *et al.*, 2015). Apesar dessas evidências, estudos indicam que a maioria dos jovens apresenta níveis de AC inferiores aos recomendados (Olds *et al.*, 2006; Pelegrini *et al.*, 2017; Tomkinson e Olds, 2007).

As recentes mudanças no estilo de vida de crianças e adolescentes, com diminuição das atividades de lazer com maior gasto energético e consequente aumento do comportamento sedentário podem desencadear redução da aptidão cardiorrespiratória nesta população (Yang *et al.*, 2019).

Níveis inadequados de AC durante a infância e a adolescência estão associados a maior prevalência de obesidade (Dwyer *et al.*, 2009), dislipidemia (Andersen *et al.*, 2004), resistência à insulina (Dwyer *et al.*, 2009) e hipertensão arterial (Andersen *et al.*, 2004) na idade adulta.

A compreensão dos fatores associados a esses baixos níveis de AC pode contribuir para o desenvolvimento de estratégias voltadas ao planejamento e implementação de intervenções direcionadas aos jovens, com o objetivo de promover o aumento da sua capacidade aeróbica (Pelegrini *et al.*, 2017).

1.4.2 Aptidão cardiorrespiratória em crianças e adolescentes portadores de DM1

Na literatura há poucos dados disponíveis sobre AC em crianças e adolescentes com DM1. No entanto, dentre os existentes, a maioria dos estudos sugerem que esta

população tem menor AC em comparação com indivíduos sem a doença (Jegdic, Roncevic e Skrabic, 2013; Komatsu *et al.*, 2005; Lukács *et al.*, 2012; Nadeau *et al.*, 2010; Nguyen *et al.*, 2015; Williams *et al*., 2011). Nesse sentido, uma revisão sistemática publicada recentemente (Steiman de Visser *et al.*, 2024) apontou que adolescentes com DM1 possuem aproximadamente 10% a menos de AC em comparação com o grupo controle sem diabetes, pareados por idade.

Embora a redução da AC esteja relacionada ao baixo nível de atividade física em crianças e adolescentes sadios (Tomkinson, Lang e Tremblay, 2019; Tomkinson e Olds, 2007), outros fatores podem influenciar a AC nesta população, como raça (Howard *et al.* , 2013; Pfeiffer *et al.*, 2007; Santos *et al.*, 2011), sexo (Armstrong e Welsman, 2019; Pfeiffer *et al.*, 2007), idade (Ribeiro *et al.*, 2013; Zaqout *et al.*, 2016), fatores socioeconômicos (Bai *et al.*, 2016; Lang *et al.*, 2018a), padrão alimentar saudável (Howe *et al.*, 2016) e composição corporal (Arango *et al.*, 2014; He *et al.*, 2011; Lee e Arslanian, 2007; Ortega, Ruiz e Castillo, 2013; Pate *et al.*, 2006; Rauner, Messe Woll, 2013; Todendi *et al.*, 2016).

Embora existam revisões sistemáticas com o objetivo de investigar a associação entre nível de atividade física, controle glicêmico e aptidão cardiorrespiratória (García-Hermoso *et al.*, 2023; Huerta-Uribe *et al.*, 2023; Eckstein *et al.*, 2022; Steiman de Visser *et al.*, 2024), assim como, outros estudos que pesquisaram a relação da AC com outras variáveis, como sexo (Eckstein *et al.*, 2021), perfil lipídico (Austin *et al*., 1993; Miculis *et al.*, 2012), e pressão arterial (Miculis *et al.*, 2012), no melhor do nosso conhecimento, ainda não foi possível determinar, quais outros fatores, sejam eles fisiológicos, bioquímicos e/ou comportamentais, podem influenciar na capacidade aeróbica de crianças e adolescentes com DM1.

Diante dessa lacuna de conhecimento, foi conduzida uma revisão de escopo com o objetivo de identificar e fornecer uma síntese abrangente dos principais fatores que impactam a aptidão cardiorrespiratória de crianças e adolescentes com DM1.

2 ARTIGO CIENTÍFICO

Artigo científico submetido para publicação no periódico "SPORTS MEDICINE", qualis CAPES Interdisciplinar A1. A estruturação do artigo baseou-se nas instruções aos autores preconizadas pelo periódico (ANEXO A).

Cardiorespiratory fitness in children and adolescents with type 1 diabetes: key factors from a scoping review

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ABSTRACT

Background Children and adolescents with type 1 diabetes mellitus (T1DM) tend to exhibit lower cardiorespiratory fitness (CRF) compared to their peers without the condition. However, the underlying factors influencing CRF in this population remain unclear. This scoping review aimed to identify the main factors associated with CRF in children and adolescents with T1DM.

Methods The review was conducted following the JBI and PRISMA-ScR guidelines. The study protocol was registered with Open Science Framework (DOI: 10.17605/OSF.IO/QJA3U). Comprehensive searches were performed in PubMed, Cochrane Library, Web of Science, Embase, LILACS, SCOPUS and SPORTDiscus databases, and gray literature, without date or language restrictions, using the descriptors: “Child”, “Adolescent”, “Diabetes Mellitus, Type 1” and “Cardiorespiratory Fitness”. The PCC framework was applied: P - individuals aged 2-18 with T1DM; C - any factor associated with CRF and C - CRF. The guiding question was: “What factors influence CRF in children and adolescents with T1DM”?

Results Twenty-seven mostly observational studies (2,346 participants) were included. Cardiopulmonary exercise testing was the primary method used to assess CRF. The most common factors in the studies were HbA1c (96.3%), body mass index (66.7%), physical activity (37.0%), body fat, lipid profile (25.9%), time of diagnosis, sex, age (22.2%), blood pressure (11.1%), and vascular function (7.4%). HbA1c, lipid profile and body fat were mostly negatively associated with CRF, whereas physical activity showed a positive association. No data on treatment adherence or diet were found.

Conclusion The results indicate that HbA1c, body fat and lipid profile were the most frequently assessed and showed predominantly inverse associations with CRF in youth with T1DM.

Physical activity, although less frequently assessed, showed consistent positive associations. These findings support the need for interdisciplinary strategies to promote active lifestyles as part of comprehensive T1DM management. The lack of data on medical treatment adherence and dietary habits is also an important gap in the literature.

Key points

- The scoping review found that higher levels of HbA1c, increased body fat, and adverse lipid profiles were commonly associated with lower cardiorespiratory fitness, whereas physical activity showed a consistent positive association in children and adolescents with type 1 diabetes mellitus.

- A notable gap in the current literature is the lack of evidence regarding the potential influence of medication adherence and dietary behaviors on cardiorespiratory fitness in this population.

- The heterogeneity of the factors studied, together with the widespread use of cardiopulmonary exercise testing, underscores the multifactorial nature of cardiorespiratory fitness and highlights the need for integrated, interdisciplinary strategies in the clinical management of adolescents with type 1 diabetes mellitus.

1 Introduction

Type 1 diabetes mellitus (T1DM) is a multifactorial autoimmune disease characterized by the destruction of pancreatic beta cells, resulting in a progressive decrease in insulin production by the body and requiring the continuous use of exogenous insulin from the time of diagnosis [1]. The condition can develop at any age, but T1DM is most diagnosed in children and young adults [2].

Compared to people without the disease, life expectancy for people with DM1 can be reduced, and at least part of this reduction can be attributed to the development and complications of DM1-related cardiovascular disease (CVD) [3]. Conversely, regular physical activity has been shown to have potential benefits in improving cardiovascular risk factors, cardiorespiratory fitness (CRF), and quality of life in this population [4]. However, evidence on the clinical benefits of exercise on physiological and biochemical outcomes in children and adolescents with T1DM is inconsistent [5], particularly in relation to physical activity as a contributor to glycemic control [6-8].

CRF is the ability of the circulatory and respiratory systems to deliver oxygen to skeletal muscle mitochondria to provide the energy required during exercise [9]. Low CRF is a strong predictor of mortality from other causes, independent of cardiovascular disease, in the general adult population [9]. In young people, CRF predicts several health indicators, including cardiometabolic health [10].

There is a paucity of data in the literature investigating CRF in children and adolescents with T1DM; however, most studies suggest that this population has lower CRF compared to those without the disease. Recently, a systematic review [11] showed a significant difference in CRF between children and adolescents with T1DM compared with controls without the disease, confirming previous studies [12-17]. However, the cited studies were unable to determine which

factors, whether physiological, biochemical and/or behavioral, contribute to the reduction in CRF in children and adolescents with T1DM.

In this sense, understanding the factors that influence CRF in different conditions resulting from T1DM may contribute to improving the health and quality of life of these children and adolescents. Therefore, to map the literature and provide a descriptive overview of the selected studies, a scoping review was conducted with the aim of identifying the main factors associated with CRF in children and adolescents with T1DM.

2 Methods

This scoping review had its research protocol registered with the Open Science Framework (OSF), under DOI: 10.17605/OSF.IO/QJA3U (supplementary information 1), and was developed and structured according to the recommendations of the Joanna Briggs Institute "JBI Manual for Evidence Synthesis" for scoping reviews [18]. The report followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (supplementary information 2) [19].

The Population, Concept and Context (PCC) strategy [18] was used to construct the research question, which was followed by the development of the guiding question: "What factors influence CRF in children and adolescents with T1DM?

The pre-specified inclusion criteria were: (1) Population: participants were individuals aged between 2 and 18 years with a diagnosis of T1DM. (2) Concept: this review considered studies that reported any biochemical; physiological and/or behavioral factors that could be related to CRF; and (3) Context: the context addressed cardiorespiratory fitness assessed by maximal oxygen uptake (VO_{2max}) or peak oxygen uptake (VO_{2peak}), measured by cardiopulmonary exercise testing, or by other exercise tests without gas analysis. Participants

with the presence of complications such as diabetic retinopathy, nephropathy and/or neuropathy and/or who have other reported diseases or comorbidities were excluded.

This scoping review considered experimental and observational study designs. It also included systematic reviews and meta-analyses, as well as theses and dissertations. Opinion articles, case series, individual case reports, qualitative research, clinical practice guidelines, review protocols and clinical trial protocols were not included.

The following databases were systematically searched Medline/PubMed, Excerpta Medica Database (EMBASE), Cochrane Library, Web of Science, Scopus, SPORTDiscus/EBSCO and Latin American and Caribbean Health Sciences Literature (LILACS). For grey literature, the Digital Library of Theses and Dissertations Network of the Coordination for the Improvement of Higher Education Personnel (CAPES), ProQuest, and Clinical Trials (NCBI) were evaluated. The databases were selected to ensure a wide range of indexed journals for the subject of the study. For grey literature, the first 100 listed were analyzed in searches that yielded more than 500 studies.

To obtain a broader search strategy, we used terms related to Population (“child”, “adolescent”, “Diabetes Mellitus, Type 1”) and Context (“Cardiorespiratory Fitness”), standardized by the Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS), in different combinations according to the search protocols of each database, without restricting the year, period of publication or language. The reference lists of all included sources of evidence were screened for additional studies. The search strategy was conducted between 19 and 20 September 2024 and is described in detail in the supplementary information 3.

The articles were selected from the databases by two independent reviewers (DNFN and SMS). All retrieved articles were imported into the Rayyan Reference Manager platform. To remove duplicates, we used the duplicate study identification feature of the platform itself. In addition, two independent reviewers manually checked the title, author, year and abstract for

any remaining duplicates. A pilot test was conducted to align the reviewers on the eligibility criteria. The two reviewers independently and blindly screened 50 studies, after which conflicts were revealed and calibration indicated good agreement between the reviewers. After the pilot test, the two reviewers (DNFN and SMS) independently and blindly read the titles and abstracts. After excluding studies that did not meet the eligibility criteria, the full texts of the selected articles were read. Studies that did not meet the inclusion criteria were classified as "excluded" according to the following criteria and in the following order: (1) wrong publication type, (2) wrong population, (3) wrong or missing context or concept, (4) wrong study design. The reasons for exclusion were recorded and are reported in the supplementary information 4. Disagreements between reviewers at each stage of the selection process were resolved by discussion and, if not resolved, a third reviewer was consulted (LFD).

The scoping review protocol was maintained throughout the process.

2.1 Data extraction

The data extracted from the selected studies were organized and presented in a spreadsheet by two reviewers (DNFN and SMS) independently. The following data were extracted: author, year of publication, country, study design, sample size, age, sex, method of measurement of cardiorespiratory fitness and equipment used and protocol, biochemical, physiological and/or behavioral factors associated with CRF and which were mentioned in at least two included studies, and main conclusions relevant to the review question. As in the selection stage, any discrepancies were resolved by discussion between the reviewers.

2.2 Synthesis of Results

The data are presented in text, figures and tables describing the participants, the approach and the context in relation to the research question and the objectives of the review. No quantitative synthesis of the data or quality assessment of the included studies was carried out, as this was not the aim of this scoping review.

3 Results

The search in the different databases resulted in 844 trials. After removing duplicates, 583 studies remained, of which 426 were excluded after reading the title and abstract. Thus, 157 studies were selected for full-text review. Two studies were excluded due to lack of access to the full text and one study was excluded due to language translation limitations by the authors, leaving 27 studies for data extraction, as shown in the PRISMA-ScR flowchart (Figure 1).

This review identified studies published between 1993 and 2024. Of the 27 [12, 16, 17, 20-43] studies included, 11 [20-23, 27-30, 32, 34, 43] (40.7%) were published in the last decade.

Regarding the country of origin, 14 [20-23, 27, 29, 30, 34, 35, 37-39, 41, 43] (51.85%) studies came from countries in the American continent, half of which were conducted in Brazil [20-23, 27, 34, 35]. This was followed by 10 [12, 17, 24-26, 28, 33, 36, 40, 42] (37.04%) studies from the European continent and three [16, 31, 32] (11.11%) from Oceania. The number of studies included, by country, can be seen in the figure 2.

Most of the included studies (n = 13; 48.15%) had an observational design, of which 10 [21, 22, 24, 25, 27-29, 36, 37, 43] (37.04%) were cross-sectional, two [17, 23] (7.41%) were case-control and one [33] (3.70%) was prospective. In 13 [12, 16, 26, 30-32, 34, 35, 38-42] (48.15%) studies the authors did not report the methodological design. Finally, one [20] (3.70%) was an intervention study.

The total sample included 2346 participants, 1736 from the T1DM group with a mean age of 13.4 ± 1.73 years, and 610 from the control group with a mean age of 13.4 ± 2.24 years. All the studies [12, 16, 17, 20-43] included both female and male participants.

The main method used to measure CRF found was the cardiopulmonary exercise test [20-23, 27, 30-34, 36-43] (n = 18; 66.67%), followed by the 20-meter shuttle run test [12, 24-26, 29, 35] (n = 6; 22.22%), the six-minute walking test [17], the 2-min step test [28] and the queen's college step test [16], with one (3.70%) study each. Regarding the association with glycated hemoglobin (HbA1c), when stratifying the studies based on the method of measuring CRF, there was a variation in the findings. Among the studies that used the cardiopulmonary exercise test, 11 found no significant association between HbA1c and CRF, while 7 identified an inverse association. On the other hand, in the studies that used other methods to assess CRF, 6 studies reported inverse associations between HbA1c levels and CRF.

The factors found in the included studies that were related to CRF were predominantly physiological and biochemical factors. In descending order of mention, these were HbA1c [12, 16, 17, 20-27, 29-43] (n = 26; 96.30%), Body Mass Index (BMI) [12, 16, 20-27, 31, 33-35, 37, 38, 40, 43] (n = 18; 66.67%), Physical Activity (PA) [12, 20, 23, 27, 33, 34, 36, 40, 42, 43] (n= 10; 37.04%), Body Fat (BF) [20, 27, 31, 35, 38, 41, 43], Total Cholesterol (TC) [20, 27, 29, 35, 37-39], Low Density Lipoprotein (LDL) [20, 27, 29, 35, 37-39], High Density Lipoprotein (HDL) [20, 27, 29, 35, 37-39], Triglycerides (TG) [20, 27, 29, 35, 37-39] in seven (25.93%) studies each, Time of Diagnosis (TD) [12, 16, 20, 31, 36, 38], age [12, 21, 22, 24-26], sex [12, 16, 24-26, 41] in six (22.22%) studies each, Blood Pressure (BP) [16, 35, 36] (n = 3; 11.11%) and Vascular Function (VF) [36, 42] (n = 2; 7.41%). No data were available on behavioral factors, such as adherence to medical treatment and dietary habits. The main characteristics of the included studies are shown in Table 1.

The level of HbA1c, which was interpreted as either glycemic or metabolic control in the studies, was the factor that showed the most inverse associations with CRF in children and adolescents with T1DM. Figure 3 shows all the factors, with the strength of the correlations determining the size of the representation on the graph.

The relationship between the factors identified in the review and CRF is described below and can be viewed in Table 2.

HbA1c was assessed in 24 studies (88.89%) [12, 16, 17, 20-27, 30-34, 36-43], of which 13 (48.15%) [12, 16, 17, 24-26, 30-33, 37, 39, 43] showed an inverse association and 11 (40.74%) [20-23, 27, 34, 36, 38, 40-42] found no association between the variables.

The association between CRF and lipid profile was analyzed in six studies (22.22%) [20, 27, 29, 35, 37, 39]. TC was reported in five (18.52%) studies [20, 27, 35, 37, 39], of which four (14.81%) studies [27, 35, 37, 39 showed an inverse association and one study (3.70%) [20] reported no significance. Three studies (11.11%) showed an inverse association for LDL [27, 35, 37] and TG [20, 35, 37]. HDL showed an inverse association in one (3.70%) study [35] and a non-significant association in five (18.52%) [20, 27, 29, 37, 39].

BF was examined in four studies (14.81%) [20, 27, 35, 41], all of which showed an inverse association with CRF. About BMI, of the 11 studies (40.74%) [12, 16, 21-27, 35, 37] that analyzed this variable, 9 [12, 16, 21-26, 37] (33.33%) reported no significance and two (7.41%) [27, 35] suggested an inverse association with CRF. Regarding PA, three studies (11.11%) [20, 23, 27] reported a positive correlation with CRF and two studies (7.41%) [12, 36] found no correlation between the variables.

Gender was analyzed in six studies (22.22%) [12, 16, 24-26, 41], of which two (7.41%) [16, 41] suggested that boys had higher CRF than girls, while the other four (14.81%) studies [12, 24-26] showed no significance between the gender. Six studies (22.22%) [12, 21, 22, 24-26] examined the relationship between age and CRF, of which only one study (3.70%) [21]

suggested an inverse relationship, while the others (n = 5; 18.52%) [12, 22, 24-26] were not significant.

Regarding BP, it was investigated in two (7.41%) [16, 35] studies, one (3.70%) [35] reported an inverse association and another [16] a non-significant one (3.70%) between the variables. TD was reported in five studies (18.52%) [12, 16, 31, 36, 38], all of which showed no association with CRF. The association between VF and CRF was also found in two studies (7.41%) [36, 42], one (3.70%) [36] showed no significance and the other (3.70%) [42] reported a positive association.

4 Discussion

The aim of this scoping review was to identify the main factors associated with CRF in children and adolescents with T1DM. The findings indicate that HbA1c levels, BMI, body fat, PA levels and lipid profile were among the most frequently investigated variables. There is evidence of inverse associations between CRF and variables such as HbA1c, lipid profile and body fat. In contrast, higher levels of PA have been shown to have a positive association with this outcome.

The growing number of studies published in the last decade [20-23, 27-30, 32, 34, 43] demonstrates the clinical relevance of this subject, particularly regarding children and adolescents. Most of these studies originate from the American countries [20-23, 27, 29, 30, 34, 35, 37-39, 41, 43], particularly Brazil [20-23, 27, 34, 35]. However, the lack of studies from other continents, such as Africa and Asia, may limit the extrapolation of results worldwide. This is principally due to socioeconomic particularities, such as disease management in terms of access to drug treatment and laboratory tests [44, 45], as well as cultural aspects, such as eating habits and physical activity, which influence the assessed outcomes [46].

In terms of study design, observational studies predominated [17, 21-25, 27-29, 33, 36, 37, 43], with cross-sectional studies standing out [21, 22, 24, 25, 27-29, 36, 37, 43]. These studies analyzed the relationship between variables over a single time interval. While cross-sectional studies are important for investigating associations, the absence of more robust longitudinal studies, which would allow a deeper understanding of the long-term effects of T1DM and the impact of a healthy and active lifestyle on CRF, is a methodological limitation that hinders the ability to make causal inferences.

About the characteristics of the sample, while most studies included participants of both sexes, the number of boys and girls was not always specified. Furthermore, few studies categorized participants by age group or pubertal stage. The fact that most studies were conducted with adolescents rather than younger age groups represents an important gap. These variables should be considered in future investigations, given their potential impact on the analyzed outcomes.

Regarding the assessment of CRF, the cardiopulmonary exercise test was the most commonly used tool in the studies included [20-23, 27, 30-34, 36-43] in this review, demonstrating its robustness and reliability, particularly in research settings [47]. This test is recognised as the most specific method for measuring CRF as it enables detailed analysis of the cardiovascular and respiratory responses to exercise [48]. However, its application in regions with lower purchasing power may be limited, which represents an obstacle to conducting studies that seek to assess CRF in these contexts. To expand the assessment possibilities in situations where the maximum effort test cannot be performed, submaximal tests are used to estimate CRF [48, 49]. These tests are more practical and less costly as they do not require specific equipment, specialised professionals or equipped laboratories [47].

However, our results suggest that how CRF is measured may affect its association with HbA1c. While cardiopulmonary exercise tests revealed a higher number of studies indicating no

significant correlation between CRF and HbA1c, indirect methods demonstrated an inverse correlation between the two variables. Thus, the lack of standardized tests makes it difficult to assess the aerobic capacity of children and adolescents with T1DM1. Therefore, it is important to develop and validate standardized protocols that consider clinical and maturational particularities to ensure methodological reproducibility in future studies.

Previous research [11-17] suggests that the CRF of children and adolescents with T1DM is lower compared to their peers without the disease. The studies included [12, 16, 17, 24-26, 30-33, 37, 39, 43] reveal a predominance of inverse associations between HbA1c and CRF. This suggests that higher HbA1c values are linked to lower CRF. This association is also supported by other studies [50-52]. However, not all studies have found this to be the case, with many reporting no significant association between the variables. This discrepancy may be related to various factors interfering with glycemic control, such as adherence to medical treatment, family involvement, and socioeconomic factors [53]. As most of the included studies are observational and do not allow cause-and-effect relationships to be established, intervention studies are essential, as they allow greater control of the variables and help reduce possible biases. This enhances the accuracy of comprehending the interrelated dynamics.

Other methodological aspect that may help explain the inconsistency in findings is the sample size. Among the studies that did not identify a significant association between HbA1c and CRF, most involved relatively small samples, potentially limiting the statistical power to detect meaningful effects. In contrast, studies reporting a significant association generally employed larger sample sizes, suggesting that statistical power may have played a role in the ability to detect such relationships.

Considering lipid profiles, studies have shown an association between higher CRF levels and improved lipid profiles, particularly total cholesterol levels. The literature suggests that the lipid profile correlates with glycemic control [54-56]. It is important to note that dietary

patterns can positively or negatively influence lipid and glycemic profiles [57], but this aspect was not controlled in most of the evaluated studies. Physical exercise has also been shown to have beneficial effects on lipid parameters in adolescents with T1DM [29]. However, the predominant design of the observational studies included, particularly the cross-sectional studies, means that these effects cannot be assessed, indicating the need for intervention studies to investigate these responses.

About body composition, the findings suggest that children and adolescents with T1DM who have a lower BF percentage tend to have a higher CRF [20, 27, 35, 41]. The same association occurs in relation to BMI, albeit in fewer studies [27, 35]. The lack of correlation in nine of the included studies [12, 16, 21-26, 37] can be explained by the fact that BMI does not differentiate between muscle mass and body fat, both of which can directly influence an individual's CRF [58, 59]. It is also important to note that other factors, such as dietary patterns and levels of physical activity, can influence these variables; however, as point out before, these factors were not considered in the analysis of the included studies' results.

Studies show that PA has a positive association with CRF. Higher levels of PA are related to an increase in CRF. However, the intensity, duration and regularity of physical activity can be determining factors in this context [60, 61]. Previous evidence indicates that moderate- to vigorous-intensity protocols promote increases in CRF in adolescents with [23] and without [60] the disease, and that those who spend more time doing moderate- to vigorous-intensity physical activity have better glycemic control [23]. Nevertheless, gaps remain in our understanding of the ideal prescription for children and adolescents with T1DM. Future studies should therefore investigate interventions that compare different physical exercise protocols, considering variables such as intensity, duration, and type of training, to identify the most effective strategies for improving CRF.

Concerning gender, boys had a higher CRF than females, as has been previously reported in individuals without the disease [62-67]. Girls usually start puberty earlier than boys of the same age [68], which may partly explain the difference observed between the sexes [63, 69]. However, the lack of a significant association in most studies suggests that age and gender alone should not be considered determinants of CRF in this population. Furthermore, studies should consider analyzing data in models categorized by sex and pubertal stage [70, 71].

There was no significant association between TD and aerobic capacity. This absence can be attributed to the cross-sectional design of most of the included studies, which limits analysis of the effects over time. However, it should be noted that a longer duration of T1DM may be related to an increased risk of chronic complications that could potentially compromise cardiorespiratory function and, consequently, CRF [72]. Conversely, T1DM may positively influence diabetes control over time, as patients may gain a better understanding of the disease, resulting in improved glycemic control and increased engagement in physical activities [73]. This could, at least in part, explain the lack of significance for this variable.

Few studies have examined the relationship between BP and VF and CRF in children and adolescents with T1DM, highlighting the need for further research in this area. Additionally, the review found no studies addressing behavioral factors such as adherence to treatment and eating habits. Therefore, it is important that future research includes these factors to understand how lifestyle and self-care influence the health of this population.

The findings of this review suggest possible associations between CRF and clinical indicators such as glycemic control, lipid profile, and body composition. Therefore, CRF is a likely marker of cardiometabolic health in children and adolescents with T1DM. Assessing CRF in clinical practice could help to monitor young people with T1DM for metabolic and cardiovascular risk factors.

Finally, it should be noted that the majority of adolescents with T1DM do not meet the recommended guidelines for physical exercise [74] and are less physically active than those without the disease [75, 76]. As exercise can improve CRF [22, 32, 40, 77], these findings reinforce the need to encourage regular physical exercise among children and adolescents with T1DM, in line with guidelines recommending at least 60 minutes of moderate to vigorous physical activity per day for this age group [78]. However, insufficient glycemic control and concerns regarding hypoglycemia during physical activity can pose challenges for children and adolescents in increasing their level of activity [79, 80]. Nevertheless, these factors should not outweigh the benefits of regular physical exercise. Interdisciplinary support and professionals trained to monitor and adapt exercise according to individual limitations and glycemic response are essential to ensure safety and adherence in this population.

This scoping review has the following limitations: its nature as a secondary study aiming to summarize or map the available evidence without critically assessing the quality of the evidence [81]; the exclusion of studies with participants with complications from TDM1 or with other reported diseases and comorbidities. However, this exclusion is justified by the low prevalence of these conditions in the target population, since complications related to T1DM tend to manifest themselves with advancing age and time of diagnosis.; the non-inclusion of an Arabic study due to translation issues; a lack of methodological clarity in some studies [12, 16, 26, 30-32, 34, 35, 38-42]; the scarcity of intervention studies. Furthermore, although the analysis of gray literature was limited to the first 100 results in searches that exceeded 500 studies, we believe that this restriction does not compromise the results of this review, considering that searches in gray literature generally have a broader and less specific scope, with less quality control and indexing. The results presented here must be interpreted with these limitations in mind.

Although our review identified various associations between physiological and biochemical factors in relation to CRF, we cannot establish a causal relationship due to the largely observational nature of the analyzed studies. In this sense, although Lima et al. [20] classified their study as quasi-experimental, no interventions or analyses of isolated conditions were identified to support this classification, meaning it must be considered observational. This finding further limits our ability to infer causality. Nevertheless, the findings of this scoping review have important clinical implications for the multidisciplinary management of T1DM and the planning of health promotion strategies for children and adolescents, and provide support for future research.

The heterogeneity of the findings and the different sample sizes highlight the need for more robust, well-designed studies. These should include intervention studies that evaluate the effectiveness of physiological, biochemical and behavioral factors in influencing CRF in children and adolescents with T1DM. In addition, studies should control for confounding variables such as food consumption, the duration, intensity and regularity of physical exercise, and T1DM. They should also use validated protocols and unified guidelines for measuring CRF to ensure consistent findings.

In conclusion, our results indicate that HbA1c and lipid profile were the most frequently assessed biochemical variables and showed predominantly inverse associations with CRF in youth with T1DM. Physical activity, although less frequently assessed, showed consistent positive associations. These findings reinforce the importance of interdisciplinary strategies that promote an active lifestyle as part of comprehensive care. CRF assessment should be incorporated into clinical practice as a functional health marker and a tool for monitoring and preventing metabolic and cardiovascular complications in this population.

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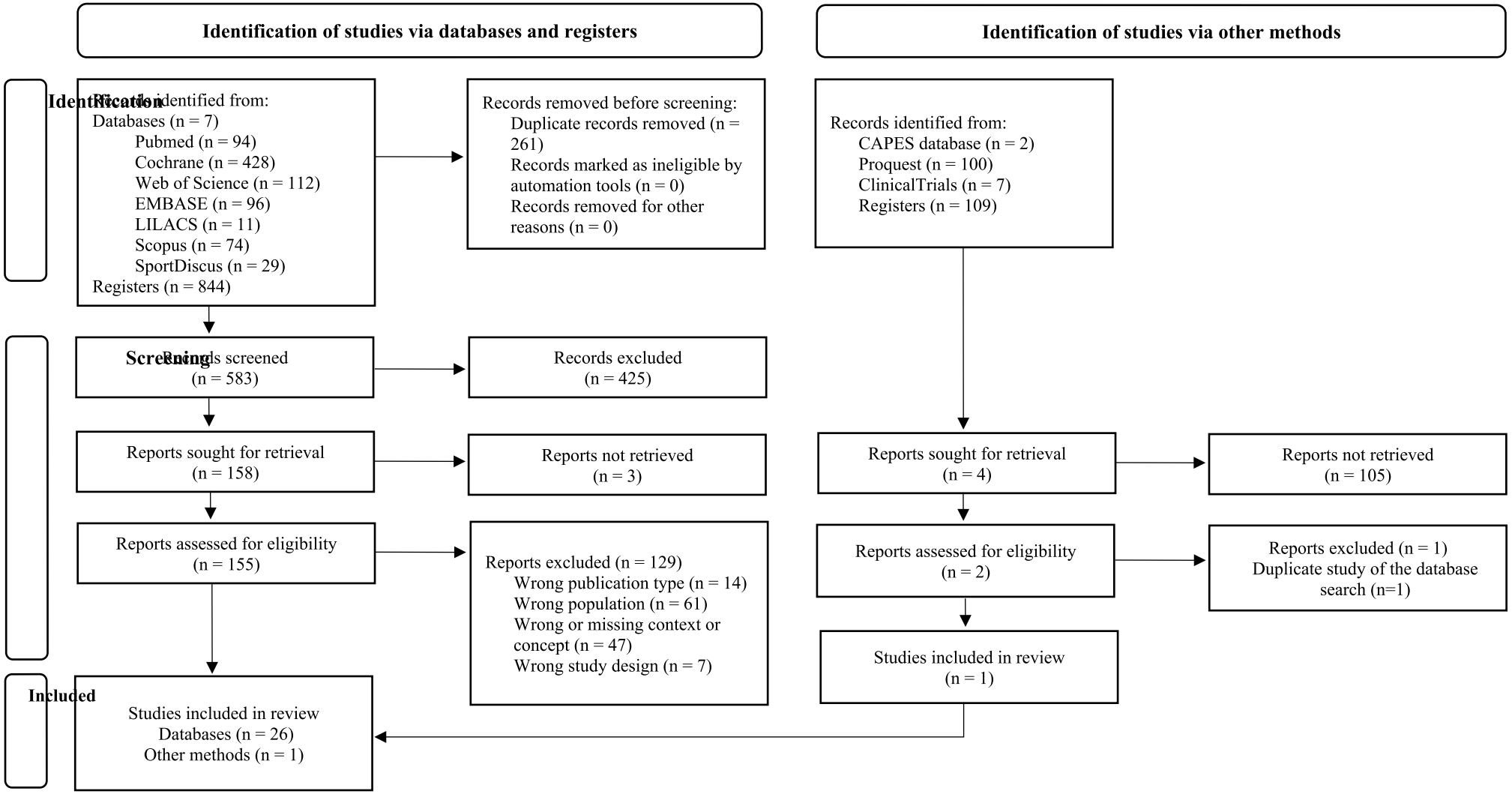

Fig.1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study selection

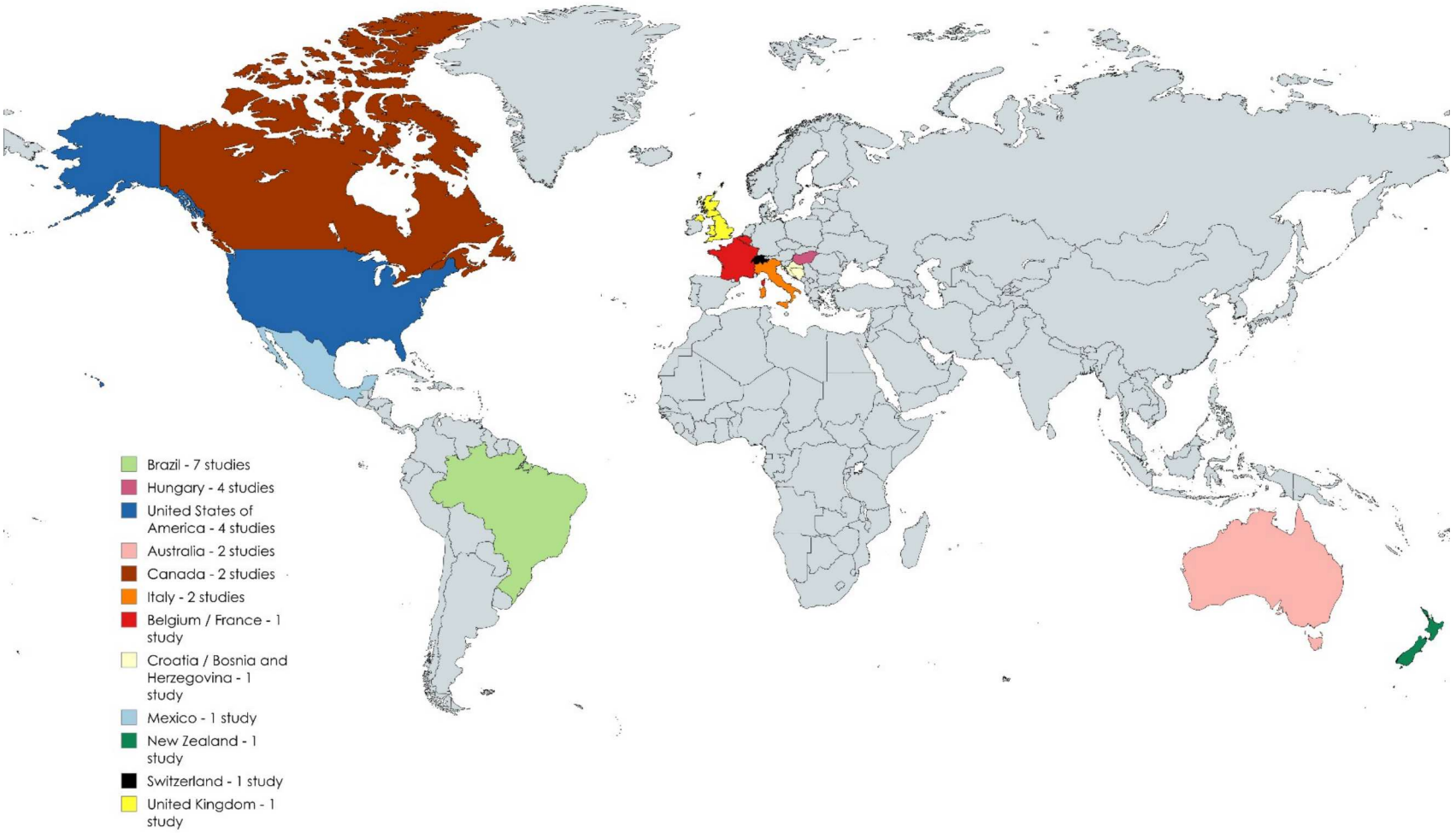

Fig. 2 Map depicting the global distribution of included studies, categorized by country of origin and corresponding study count, to identify geographical trends and research concentration

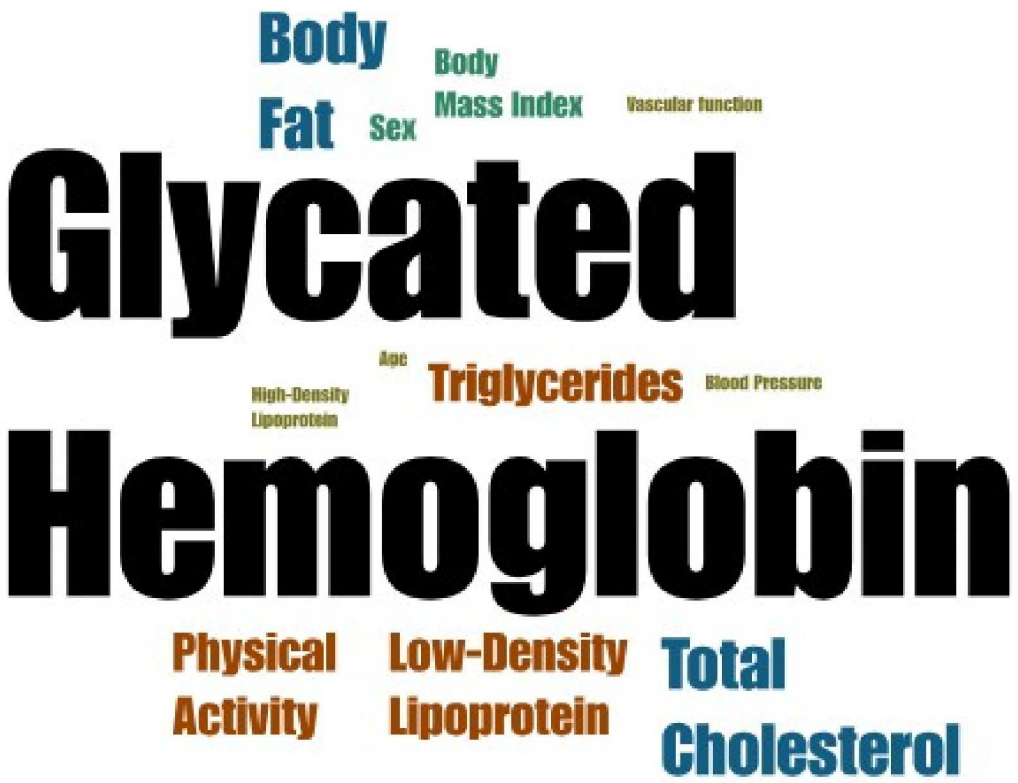

Fig. 3 Graphical representation of factors associated with cardiorespiratory fitness (CRF) in children and adolescents with type 1 diabetes mellitus (T1DM). The size of each element reflects the strength of the correlation. Among the identified factors, only Physical Activity showed a positive correlation with CRF; all other variables were inversely correlated

Table1. Characteristics of included studies

Author (Data)	Country	Population				Design	Measurements method	Outcomes analyzed
		n	Sex	Groups	Age[1]			
Lima et al., 2024	Brazil	32	♀/♂	T1DM	13.09 ± 1.90	Quasi-experimental	Cardiopulmonary Exercise Test	TC, LDL, HDL, TG, HbA1c, BMI, BF, TD, PA
Calella et al., 2023	Italy	74	♀/♂	T1DM	14.7 ± 1.6	Cross-sectional	2-Min Step Test	PA
Cordeiro et al., 2021	Brazil	34	♀/♂	T1DM	13.0 ± 1.9	Cross-sectional	Cardiopulmonary Exercise Test	TC, LDL, HDL, TG, HbA1c, BMI, BF
Wu et al., 2021	Canada	67	♀/♂	T1DM/ HC	14.02 ± 2.89 (T1DM)/ 13.58 ± 3.46 (HC)	Cross-sectional	20-meter shuttle run test	TC, LDL, HDL, TG, HbA1c
Faulkner et al., 2019	USA	95	♀/♂	T1DM	15.4 ± 1.9	Not reported	Cardiopulmonary Exercise Test	HbA1c

Table continued

Author (Data)	Country	Population				Design	Measurements method	Outcomes analyzed
		n	Sex	Groups	Age[1]			
Jesus et al., 2019	Brazil	22	♀/♂	T1DM/ HC	13.80 ± 1.90 (T1DM)/ 12.78 ± 1.39 (HC)	Cross-sectional	Cardiopulmonary Exercise Test	HbA1c, BMI, age
Gusso et al., 2017	Australian	75	♀/♂	T1DM/ HC	15.6 ± 1.3 (T1DM Training)/ 15.5 ± 0.9 (T1DM Nontraining)/ 16.7 ± 1.5 (HC)	Not reported	Cardiopulmonary Exercise Test	HbA1c
Lima et al., 2017a	Brazil	8	♀/♂	T1DM	13.81 ± 2.00	Cross-sectional	Cardiopulmonary Exercise Test	HbA1c, BMI, age
Lima et al., 2017b	Brazil	154	♀/♂	T1DM/ HC	12.36 ± 1.52 (T1DM)/ 11.64 ± 0.73 (HC)	Case-control	Cardiopulmonary Exercise Test	HbA1c, BMI, PA
Nascimento et al., 2017	Brazil	37	♀/♂	T1DM/ HC	12.8 (9.7; 13.7) (T1DM good glycemic control)/ 12.6 (11.4; 13.6) (T1DM poor glycemic control)/ 13.1 (12.8; 13.3) (HC)	Not reported	Cardiopulmonary Exercise Test	HbA1c, BMI, PA

Table continued

Author (Data)	Country	Population				Design	Measurements method	Outcomes analyzed
		n	Sex	Groups	Age			
Nguyen et al., 2015	Canada	24	♀/♂	T1DM/ HC	13.8 ± 3.0 (T1DM with good glycemic control)/ 14.2 ± 1.3 (T1DM with poor glycemic control)/ 13.6 ± 2.6 (HC)	Cross-sectional	Cardiopulmonary Exercise Test	HbA1c, BMI, BF, PA
Lukács et al., 2014	Hungary	239	♀/♂	T1DM	13.09 ± 3.01 (M)/ 13.64 ± 2.73 (F)	Not reported	20-meter shuttle run test	HbA1c, BMI, sex, age
Jegdic et al., 2013	Croatia, Bosnia and Herzegovina	200	♀/♂	T1DM/ HC	13.0 ± 2.9 (All participants)	Case-control	Six-minute walking test	HbA1c
Lukács et al., 2013a	Hungary	106	♀/♂	T1DM	13.22 ± 3.08	Cross-sectional	20-meter shuttle run test	HbA1c, BMI, sex, age
Lukács et al., 2013b	Hungary	239	♀/♂	T1DM	13.29 ± 2.85 (CSII)/ 13.44 ± 2.90 (MDI)	Cross-sectional	20-meter shuttle run test	HbA1c, BMI, sex, age

Table continued

Author (Data)	Country	Population				Design	Measurements method	Outcomes analyzed
		n	Sex	Groups	Age			
Fintini et al., 2012	Italy	66	♀/♂	T1DM/ HC	10.2 ± 0.8 (T1DM)/ 10.6 ± 1.4 (HC)	Prospective study	Cardiopulmonary Exercise Testing	HbA1c, BMI, PA
Gusso et al., 2012	New Zealand	75	♀/♂	T1DM/ HC	15.6 ± 0.2 (T1DM)/ 16.6 ± 0.2 (HC)	Not reported	Cardiopulmonary Exercise Testing	HbA1c, BMI, BF, TD
Lukács et al., 2012	Hungary	236	♀/♂	T1DM/ HC	10.60 ± 1.53 (F T1DM)/ 10.80 ± 1.15 (F HC) / 10.53 ± 1.50 (M T1DM)/ 11.02 ± 1.13 (M HC)/15.79 ±1.81(F T1DM)/ 16.01 ± 1.84(F HC)/ 15.76 ± 1.75(M T1DM)/ 15.41 ± 1.71 (M HC)	Not reported	20-meter shuttle run test	HbA1c, BMI, TD, PA, sex, age
Miculis et al., 2012	Brazil	50	♀/♂	T1DM	12.67 ± 2.29 (M)/ 11.89 ± 1.57 (F)	Not reported	20-meter shuttle run test	TC, LDL, HDL, TG, HbA1c, BP, BMI, BF

Table continued

Author (Data)	Country	Population				Design	Measurements method	Outcomes analyzed
		n	Sex	Group	Age			
Kornhauser et al., 2011	México	10	♀/♂	T1DM	15.3 (15.3-17.3)	Not reported	Cardiopulmonary Exercise Testing	TC, LDL, HDL, TG, HbA1c, BMI, BF, TD
Williams et al., 2011	Australia	150	♀/♂	T1DM/HC	10.9 ± 2.2 (T1DM)/ 10.9 ± 1.9 (HC)	Not reported	Queen's College Step Test	HbA1c, BP, BMI, TD, sex
Trigona et al., 2010	Switzerland	74	♀/♂	T1DM/HC	11.5 (10.2-12.8) T1DM/ 10.7 (9.6-11.8) HC	Cross-sectional	Cardiopulmonary Exercise Testing	HbA1c, VF, BP, TD, PA
Michaliszyn et al., 2009	USA	109	♀/♂	T1DM	15.3 ± 1.9	Not reported	Cardiopulmonary Exercise Testing	TC, LDL, HDL, TG, HbA1c
Roche et al., 2008	UK	29	♀/♂	T1DM	12.5 ± 2.0	Not reported	Cardiopulmonary Exercise Testing	HbA1c, VF, PA
Heyman et al., 2007	Belgium and France	38	♀/♂	T1DM/HC	15.9 ± 1.3 T1DM/ 16.6 ± 1.1 HC	Not reported	Cardiopulmonary Exercise Testing	HbA1c, BMI, PA

Table continued

Author (Data)	Country	Population				Design	Measurements method	Outcomes analyzed
		n	Sex	Group	Age			
Kertzer et al., 1994	USA	44	♀/♂	T1DM	11.5 ± 2.5 (8-15) M/ 11.0 ± 1.7 (7-14) F	Not reported	Cardiopulmonary Exercise Testing	HbA1c, BF, sex
Austin et al., 1993	USA	59	♀/♂	T1DM/HC	15.6 ± 2.5 (T1DM)/ 14.2 ± 2.1 (HC)	Cross-sectional	Cardiopulmonary Exercise Testing	TC, LDL, HDL, TG, HbA1c, BMI

Legend: ♀/ F - female; ♂/ M - male; BF - Body Fat; BMI - Body Mass Index; BP - Blood Pressure; CSII - Continuous Subcutaneous Insulin Infusion; HbA1c - Glycated Hemoglobin; HC - Health Control; HDL - High-Density Lipoprotein; LDL - Low-Density Lipoprotein; MDI - multiple daily injections; n - Sample size; PA - Physical Activity; T1DM - Type 1 Diabetes Mellitus; TC - Total Cholesterol; TD - Time of Diagnostic; TG - Triglycerides; UK - United Kingdom; USA - United States of American; VF - Vascular Function; [1] Age described by mean ± standard deviation, or median (1st quartile, 3rd quartile) or (95% confidence intervals)

Table 2. Key Findings of Included Studies on Cardiorespiratory Fitness (CRF) in Children and Adolescents with Type 1 Diabetes Mellitus

Author (Data)	TC	LDL	HDL	TG	HbA1c	VF	BP	BMI	BF	TD	PA	Sex	Age	Conclusion
Lima et al., 2024	↔	↔	↔	↓+	↔	NA	NA	-	↓++	-	↑+	NA	NA	The study suggests that a good level of physical activity positively influences cardiorespiratory fitness and lipid profile
Calella et al., 2023	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	↑~	NA	NA	The study showed a positive correlation between aerobic capacity, measured by the 2-MST, and the overall IPAQ score, as well as time spent in moderate to vigorous physical activity
Cordeiro et al., 2021	↓~	↓~	↔	↔	↔	NA	NA	↓~	↓+	NA	NA	NA	NA	The results show that better cardiorespiratory fitness is associated with lower values of body fat, BMI, total cholesterol and LDL levels. It can be considered a protective factor for the body composition and lipid profile of adolescents with T1DM
Wu et al., 2021	-	-	↔	-	-	NA	NA	NA	NA	NA	NA	NA	NA	There was no correlation between $VO_{2máx}$ values and HDL
Faulkner et al., 2019	NA	NA	NA	NA	↓~	NA	NA	NA	NA	NA	NA	NA	NA	Inverse association were found between average HbA1c (values averaged over 1 year) and cardiorespiratory fitness
Jesus et al., 2019	NA	NA	NA	NA	↔	NA	NA	↔	NA	NA	NA	NA	↓++	No significant correlation was found between $VO_{2máx}$ values and HbA1 or BMI. A strong inverse correlation was found with age

Table continued

Author (Data)	TC	LDL	HDL	TG	HbA1c	VF	BP	BMI	BF	TD	PA	Sex	Age	Conclusion
Gusso et al., 2017	NA	NA	NA	NA	↓	NA	NA	NA	NA	NA	NA	NA	NA	Exercise training enhanced aerobic capacity without impacting glycemic control in individuals with diabetes, suggesting that glycemic status and exercise training may independently contribute to aerobic capacity improvements
Lima et al., 2017a	NA	NA	NA	NA	↔	NA	NA	↔	NA	NA	NA	NA	↔	There were no significant correlations between VO_2 and BMI, nor between VO_2 and HbA1c
Lima et al., 2017b	NA	NA	NA	NA	↔	NA	NA	↔	NA	NA	↑+	NA	NA	Greater $VO_{2máx}$ values were associated with higher time spent on moderate-to-vigorous intensity activities and lower time spent on sedentary activities
Nascimento et al., 2017	NA	NA	NA	NA	↔	NA	NA	-	NA	NA	-	NA	NA	HbA1c levels were not associated with $VO_{2máx}$, which was similar across uncontrolled T1DM patients, controlled T1DM patients, and healthy controls, indicating that HbA1c does not impact aerobic fitness

Table continued

Author (Data)	TC	LDL	HDL	TG	HbA1c	VF	BP	BMI	BF	TD	PA	Sex	Age	Conclusion
Nguyen et al., 2015	NA	NA	NA	NA	↓+	NA	NA	-	-	NA	-	NA	NA	Children with T1DM with good glycemic control showed fitness levels comparable to healthy controls, while those with poor glycemic control had reduced aerobic fitness
Lukács et al., 2014	NA	NA	NA	NA	↓~	NA	NA	↔	NA	NA	NA	↔	↔	$VO_{2máx}$ was a significant predictor of blood glucose control, explaining 12.5% of its variance, with higher $VO_{2máx}$ tending to correlate with lower HbA1c levels
Jegdic et al., 2013	NA	NA	NA	NA	↓	NA	NA	NA	NA	NA	NA	NA	NA	HbA1c levels influenced the physical fitness of children with T1DM
Lukács et al., 2013a	NA	NA	NA	NA	↓~	NA	NA	↔	NA	NA	NA	↔	↔	Better cardiorespiratory fitness associated with favorable metabolic control in patients with T1DM
Lukács et al., 2013b	NA	NA	NA	NA	↓	NA	NA	↔	NA	NA	NA	↔	↔	Good physical fitness has an important role in achieving better metabolic control
Fintini et al., 2012	NA	NA	NA	NA	↓	NA	NA	-	NA	NA	-	NA	NA	Glycemic control may play a role in cardiovascular performance

Table continued

Author (Data)	TC	LDL	HDL	TG	HbA1c	VF	BP	BMI	BF	TD	PA	Sex	Age	Conclusion
Gusso et al., 2012	NA	NA	NA	NA	↓	NA	NA	-	-	↔	NA	NA	NA	Aerobic capacity was correlated with glycemic control but not with diabetes duration
Lukács et al., 2012	NA	NA	NA	NA	↓	NA	NA	↔	NA	↔	↔	↔	↔	Better $VO_{2máx}$ proved to be the single predictor of favorable HbA1c
Miculis et al., 2012	↓	↓	↓	↓	-	NA	↓ SBP	↓	↓	NA	NA	NA	NA	This study reinforces the inverse correlation between aerobic capacity and traditional cardiovascular risk factors, independent of body adiposity
Kornhauser et al., 2011	-	-	-	-	↔	NA	NA	-	-	↔	NA	NA	NA	HbA1c were not associated with $VO_{2máx}$
Williams et al., 2011	NA	NA	NA	NA	↓	NA	↔	↔	NA	↔	NA	↑	NA	Both gender and glycemic control (HbA1c) were significantly associated with cardiorespiratory fitness, with female sex and poorer glycemic control associated with reduced fitness
Trigona et al., 2010	NA	NA	NA	NA	↔	↔	-	NA	NA	↔	↔	NA	NA	HbA1c, FMD and IMT were not associated with $VO_{2máx}$

Table continued

Author (Data)	TC	LDL	HDL	TG	HbA1c	VF	BP	BMI	BF	TD	PA	Sex	Age	Conclusion
Michalis zyn et al., 2009	↓	↔	↔	↔	↓	NA	NA	NA	NA	NA	NA	NA	NA	Greater fitness levels predicted both better glycemic control and total cholesterol in adolescents with T1DM
Roche et al., 2008	NA	NA	NA	NA	↔	↑	NA	NA	NA	NA	-	NA	NA	Aerobic fitness may be an important indicator or mediator of effective microvascular endothelial function in youth with T1DM
Heyman et al., 2007	NA	NA	NA	NA	↔	NA	NA	-	NA	NA	-	NA	NA	No variable was associated with $VO_{2máx}$
Kertzer et al., 1994	NA	NA	NA	NA	↔	NA	NA	NA	↓++	NA	NA	↑	NA	Boys tended to be in better physical condition than girls of similar ages, particularly in the 12–15-year range. A highly significant negative correlation between peak VO_2 and percent body fat was found
Austin et al., 1993	↓~	↓~	↔	↓~	↓~	NA	NA	↔	NA	NA	NA	NA	NA	Physical fitness is an important factor associated with lipid levels, lipoprotein and metabolism control in adolescents with T1DM

Legend: ↔ Not significant; ↑ Directly correlated; ↓ Inversely correlated; ~ Weak; + Moderate; ++ Strong; - not reported in the model; BF – Body Fat; BMI – Body Mass Index; BP – Blood Pressure; FMD – flow mediated dilation; HbA1c – Glycated Hemoglobin; HDL – High-Density Lipoprotein; IMT – intima media thickness; LDL – Low-Density Lipoprotein; LDL – Low-Density Lipoprotein; NA – Not Assessed; PA – Physical Activity; SBP – systolic blood pressure; T1DM – Type 1 Diabetes Mellitus; TC – Total Cholesterol; TD – Time of Diagnostic; TG – Triglycerides; VF – Vascular Function (FMD, IMT e microvascular endothelial function)

3 CONCLUSÃO GERAL

A revisão de escopo demonstrou que a HbA1c, o IMC, o nível de AF, o % de gordura, o perfil lipídico, o tempo de diagnóstico da doença, a idade e o sexo dos participantes foram os fatores relacionados com AC de crianças e adolescentes com DM1 mais relatados na literatura. Complementarmente, foi verificado que a AC está associada negativamente aos fatores HbA1c, perfil lipídico, gordura corporal e positivamente com o nível de atividade física. Esses resultados reforçam a importância do controle glicêmico e a implementação de programas de exercício físico como estratégias para a promoção da saúde cardiometabólica dessa população.

Os achados desta revisão indicam que a temática ainda está em desenvolvimento, com oportunidades para futuras pesquisas que investiguem, principalmente, fatores comportamentais e cardiovasculares e sua relação com a AC, especialmente em estudos com intervenção mais robustos metodologicamente.

Por fim, sugere-se que a AC seja incorporada na prática clínica como um possível marcador de risco cardiovascular e metabólico no contexto do manejo do DM1 na população infanto-juvenil.

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APÊNDICE A – Material suplementar do artigo

Supplementary Information (SI)

Cardiorespiratory fitness in children and adolescents with type 1 diabetes: key factors from a scoping review

Sports Medicine

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This document includes:

SI1. OSF scoping review protocol

The scoping review protocol is available at: https://osf.io/qja3u/.

SI2. Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	01
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	02
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	03-04
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	03-04
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	05
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	05
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	05-06
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	05-06, Supplementary Information
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	06
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	06-07
Data items	11	List and define all variables for which data were sought and	05-06

		any assumptions and simplifications made.	
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Not applicable
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	07

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	07, Supplementary Information
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	07-09
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not applicable
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	07-09
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	07-09
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	09-13
Limitations	20	Discuss the limitations of the scoping review process.	13
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	14
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	Not applicable

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

SI3. Search strategies applied in the main databases

	MESH TERM	ENTRY TERM	SIMILAR TERM
Population Individuals aged 2 to 18 years diagnosed with T1DM	Child Minors Child, Preschool Adolescent Diabetes Mellitus, Type 1	Children Minor Preschool Child Children, Preschool Preschool Children Adolescents Adolescence Youth Youths Teens Teen Teenagers Teenager Type 1 Diabetes Diabetes, Type 1 Diabetes Mellitus, Insulin-Dependent Diabetes Mellitus, Insulin Dependent Insulin-Dependent Diabetes Mellitus Diabetes Mellitus, Juvenile-Onset Diabetes Mellitus, Juvenile Onset Juvenile-Onset Diabetes Mellitus IDDM Type 1 Diabetes Mellitus Insulin-Dependent Diabetes Mellitus 1 Insulin Dependent Diabetes Mellitus 1 Juvenile-Onset Diabetes Diabetes, Juvenile-Onset Juvenile Onset Diabetes	
Context Cardiorespiratory fitness	Cardiorespiratory Fitness	Fitness, Cardiorespiratory	Exercise Capacity Functional Capacity Vo2max Maximum O2 Consumption Maximum Oxygen Consumption Vo2peak Peak O2 Consumption Peak Oxygen Consumption Aerobic Capacity

Search Strategy, Date and Results of the Search by database

DATABASE	SEARCH STRATEGY	DATE	RESULTS
Pubmed	**#1 Child:** (Child [MeSH Terms] OR Children [Title/Abstract] OR Minor [MeSH Terms] OR Minors [Title/Abstract] OR "Child, Preschool" [MeSH Terms] OR "Preschool Child" [Title/Abstract] OR "Children, Preschool" [Title/Abstract] OR "Preschool Children" [Title/Abstract]) **#2 Adolescent:** (Adolescent [MeSH Terms] OR Adolescents [Title/Abstract] OR Adolescence [Title/Abstract] OR Youth [Title/Abstract] OR Youths [Title/Abstract] OR Teens [Title/Abstract] OR Teen [Title/Abstract] OR Teenagers [Title/Abstract] OR Teenager [Title/Abstract]) **#3 Diabetes Mellitus, Type 1:** ("Diabetes Mellitus, Type 1" [MeSH Terms] OR **"**Type 1 Diabetes" [Title/Abstract] OR "Diabetes, Type 1" [Title/Abstract] OR "Diabetes Mellitus, Insulin-Dependent" [Title/Abstract] OR "Diabetes Mellitus, Insulin Dependent" [Title/Abstract] OR "Insulin-Dependent Diabetes Mellitus" [Title/Abstract] OR "Diabetes Mellitus, Juvenile-Onset" [Title/Abstract] OR "Diabetes Mellitus, Juvenile Onset" [Title/Abstract] OR "Juvenile-Onset Diabetes Mellitus" [Title/Abstract] OR IDDM [Title/Abstract] OR "Type 1 Diabetes Mellitus" [Title/Abstract] OR "Insulin-Dependent Diabetes Mellitus 1" [Title/Abstract] OR "Insulin Dependent Diabetes Mellitus 1" [Title/Abstract] OR "Juvenile-Onset Diabetes" [Title/Abstract] OR "Diabetes, Juvenile-Onset" [Title/Abstract] OR "Juvenile Onset Diabetes" [Title/Abstract]) **#4 Cardiorespiratory Fitness:** ("Cardiorespiratory Fitness" [MeSH Terms] OR "Fitness, Cardiorespiratory" [Title/Abstract] OR "Exercise Capacity" [Title/Abstract] OR "Functional Capacity" [Title/Abstract] OR "Vo2max" [Title/Abstract] OR "Maximum O2 Consumption" [Title/Abstract] OR "Maximum Oxygen Consumption" [Title/Abstract] OR "Vo2peak" [Title/Abstract] OR "Peak O2 Consumption" [Title/Abstract] OR "Peak Oxygen Consumption" [Title/Abstract] OR "Aerobic Capacity" [Title/Abstract]) **Search:** (#1 OR #2) AND #3 AND #4	19/09/2024	94
Cochrane Library	**#1:** (Child):ti,ab,kw **#2:** (Children):ti,ab,kw **#3:** (Minor):ti,ab,kw **#4:** (Minors):ti,ab,kw **#5:** (Child, Preschool):ti,ab,kw **#6:** (Preschool Child):ti,ab,kw **#7:** (Children, Preschool):ti,ab,kw **#8:** (Preschool Children):ti,ab,kw **#9:** (Adolescent):ti,ab,kw **#10:** (Adolescents):ti,ab,kw	19/09/2024	428

	#11: (Adolescence):ti,ab,kw **#12:** (Youth):ti,ab,kw **#13:** (Youths):ti,ab,kw **#14:** (Teens):ti,ab,kw **#15:** (Teen):ti,ab,kw **#16:** (Teenagers):ti,ab,kw **#17:** (Teenager):ti,ab,kw **#18:** (Diabetes Mellitus, Type 1):ti,ab,kw **#19:** (Type 1 Diabetes):ti,ab,kw **#20:** (Diabetes, Type 1):ti,ab,kw **#21:** (Diabetes Mellitus, Insulin-Dependent):ti,ab,kw **#22:** (Diabetes Mellitus, Insulin Dependent):ti,ab,kw **#23:** (Insulin-Dependent Diabetes Mellitus):ti,ab,kw **#24:** (Diabetes Mellitus, Juvenile-Onset):ti,ab,kw **#25:** (Diabetes Mellitus, Juvenile Onset):ti,ab,kw **#26:** (Juvenile-Onset Diabetes Mellitus):ti,ab,kw **#27:** (IDDM):ti,ab,kw **#28:** (Type 1 Diabetes Mellitus):ti,ab,kw **#29:** (Insulin-Dependent Diabetes Mellitus 1):ti,ab,kw **#30:** (Insulin Dependent Diabetes Mellitus 1):ti,ab,kw **#31:** (Juvenile-Onset Diabetes):ti,ab,kw **#32:** (Diabetes, Juvenile-Onset):ti,ab,kw **#33:** (Juvenile Onset Diabetes):ti,ab,kw **#34:** (Cardiorespiratory Fitness) **#35:** (Fitness, Cardiorespiratory) **#36:** (Exercise Capacity) **#37:** (Functional Capacity) **#38:** (Vo2max) **#39:** (Maximum O2 Consumption) **#40:** (Maximum Oxygen Consumption) **#41:** (Vo2peak) **#42:** (Peak O2 Consumption) **#43:** (Peak Oxygen Consumption) **#44:** (Aerobic Capacity) **Search:** (#1 OR #2 OR #3 OR #04 OR #5 OR #6 OR #07 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17) AND (#18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33) AND (#34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44)		
Web of Science	**#1** Child: TS=(Child) OR TS=(Children) OR TS=(Minor) OR TS=(Minors) OR TS=(“Child, Preschool”) OR TS=("Preschool Child") OR TS=(“Children, Preschool”) OR TS=(“Preschool Children”) **#2** Adolescent: TS=(Adolescent) OR TS=(adolescents) OR TS=(Adolescence) OR TS=(Youth) OR TS=(Youths) OR TS=(Teens) OR TS=(Teen) OR TS=(Teenagers) OR TS=(Teenager) **#3** Diabetes Mellitus, Type 1: TS=("Diabetes Mellitus, Type 1") OR TS=(“Type 1 Diabetes”) OR TS=(“Diabetes, Type 1”) OR TS=(“Diabetes Mellitus, Insulin-Dependent”) OR TS=(“Diabetes Mellitus, Insulin Dependent”) OR TS=(“Insulin-	19/09/2024	112

	Dependent Diabetes Mellitus") OR TS=("Diabetes Mellitus, Juvenile-Onset") OR TS=("Diabetes Mellitus, Juvenile Onset") OR TS=("Juvenile-Onset Diabetes Mellitus") OR TS=(IDDM) OR TS=("Type 1 Diabetes Mellitus") OR TS=("Insulin-Dependent Diabetes Mellitus 1") OR TS=("Insulin Dependent Diabetes Mellitus 1") OR TS=("Juvenile-Onset Diabetes") OR TS=("Diabetes, Juvenile-Onset") OR TS=("Juvenile Onset Diabetes") **#4** Cardiorespiratory Fitness: TS=("Cardiorespiratory Fitness") OR TS=("Fitness, Cardiorespiratory") OR TS=("Exercise Capacity") OR TS=("Functional Capacity") OR TS=(Vo2max) OR TS=("Maximum O2 Consumption") OR TS=("Maximum Oxygen Consumption") OR TS=(Vo2peak) OR TS=("Peak O2 Consumption") OR TS=("Peak Oxygen Consumption") OR TS=("Aerobic Capacity") **Search:** (#1 OR #2) AND #3 AND #4		
Embase	**#1 Child:** 'child':ab,ti OR 'children':ab,ti OR 'minor':ab,ti OR 'minors':ab,ti OR 'child, preschool':ab,ti OR 'preschool child':ab,ti OR 'children, preschool':ab,ti OR 'preschool children':ab,ti **#2 Adolescent:** 'adolescent':ab,ti OR 'adolescents':ab,ti OR 'adolescence':ab,ti OR 'youth':ab,ti OR 'youths':ab,ti OR 'teens':ab,ti OR 'teen':ab,ti OR 'teenagers':ab,ti OR 'teenager':ab,ti **#3 Diabetes Mellitus, Type 1:** 'diabetes mellitus, type 1':ab,ti OR 'type 1 diabetes':ab,ti OR 'diabetes, type 1':ab,ti OR 'diabetes mellitus, insulin-dependent':ab,ti OR 'diabetes mellitus, insulin dependent':ab,ti OR 'insulin-dependent diabetes mellitus':ab,ti OR 'diabetes mellitus, juvenile-onset':ab,ti OR 'diabetes mellitus, juvenile onset':ab,ti OR 'juvenile-onset diabetes mellitus':ab,ti OR 'iddm':ab,ti OR 'type 1 diabetes mellitus':ab,ti OR 'insulin-dependent diabetes mellitus 1':ab,ti OR 'insulin dependent diabetes mellitus 1':ab,ti OR 'juvenile-onset diabetes':ab,ti OR 'diabetes, juvenile-onset':ab,ti OR 'juvenile onset diabetes':ab,ti **#4 Cardiorespiratory Fitness:** 'cardiorespiratory fitness':ab,ti OR 'fitness, cardiorespiratory':ab,ti OR 'exercise capacity':ab,ti OR 'functional capacity':ab,ti OR 'vo2max':ab,ti OR 'maximum o2 consumption':ab,ti OR 'maximum oxygen consumption':ab,ti OR 'vo2peak':ab,ti OR 'peak o2 consumption':ab,ti OR 'peak oxygen consumption':ab,ti OR 'aerobic capacity':ab,ti **Search:** (#1 OR #2) AND #3 AND #4	19/09/2024	96
Scopus	**#1 Child:** (Child OR Children OR Minor OR Minors OR "Child, Preschool" OR "Preschool Child" OR "Children, Preschool" OR "Preschool Children") **#2 Adolescent:** (Adolescent OR Adolescents OR	19/09/2024	74

	Adolescence OR Youth OR Youths OR Teens OR Teen OR Teenagers OR Teenager) **#3 Diabetes Mellitus, Type 1:** ("Diabetes Mellitus, Type 1" OR **"**Type 1 Diabetes" OR "Diabetes, Type 1" OR "Diabetes Mellitus, Insulin-Dependent" OR "Diabetes Mellitus, Insulin Dependent" OR "Insulin-Dependent Diabetes Mellitus" OR "Diabetes Mellitus, Juvenile-Onset" OR "Diabetes Mellitus, Juvenile Onset" OR "Juvenile-Onset Diabetes Mellitus" OR IDDM OR "Type 1 Diabetes Mellitus" OR "Insulin-Dependent Diabetes Mellitus 1" OR "Insulin Dependent Diabetes Mellitus 1" OR "Juvenile-Onset Diabetes" OR "Diabetes, Juvenile-Onset" OR "Juvenile Onset Diabetes") **#4 Cardiorespiratory Fitness:** ("Cardiorespiratory Fitness" OR "Fitness, Cardiorespiratory" OR "Exercise Capacity" OR "Functional Capacity" OR "Vo2max" OR "Maximum O2 Consumption" OR "Maximum Oxygen Consumption" OR "Vo2peak" OR "Peak O2 Consumption" OR "Peak Oxygen Consumption" OR "Aerobic Capacity") **Search:** (TITLE-ABS ((child OR children OR minor OR minors OR "Child, Preschool" OR "Preschool Child" OR "Children, Preschool" OR "Preschool Children"))) OR (TITLE-ABS ((adolescent OR adolescents OR adolescence OR youth OR youths OR teens OR teen OR teenagers OR teenager))) AND (TITLE-ABS (("Diabetes Mellitus, Type 1" OR "Type 1 Diabetes" OR "Diabetes, Type 1" OR "Diabetes Mellitus, Insulin-Dependent" OR "Diabetes Mellitus, Insulin Dependent" OR "Insulin-Dependent Diabetes Mellitus" OR "Diabetes Mellitus, Juvenile-Onset" OR "Diabetes Mellitus, Juvenile Onset" OR "Juvenile-Onset Diabetes Mellitus" OR iddm OR "Type 1 Diabetes Mellitus" OR "Insulin-Dependent Diabetes Mellitus 1" OR "Insulin Dependent Diabetes Mellitus 1" OR "Juvenile-Onset Diabetes" OR "Diabetes, Juvenile-Onset" OR "Juvenile Onset Diabetes"))) AND (TITLE-ABS (("Cardiorespiratory Fitness" OR " Fitness, Cardiorespiratory" OR "Exercise Capacity" OR "Functional Capacity" OR "Vo2max" OR "Maximum O2 Consumption" OR "Maximum Oxygen Consumption" OR "Vo2peak" OR "Peak O2 Consumption" OR "Peak Oxygen Consumption" OR "Aerobic Capacity")))		
SPORTDiscus	**#1 Child:** AB (Child OR Children OR Minor OR Minors OR "Child, Preschool" OR "Preschool Child" OR "Children, Preschool" OR "Preschool Children") **#2 Adolescent:** AB (Adolescent OR Adolescents OR Adolescence OR Youth OR Youths OR Teens OR Teen OR Teenagers OR Teenager)	19/09/2024	29

	#3 Diabetes Mellitus, Type 1: AB ("Diabetes Mellitus, Type 1" OR **"**Type 1 Diabetes" OR "Diabetes, Type 1" OR "Diabetes Mellitus, Insulin-Dependent" OR "Diabetes Mellitus, Insulin Dependent" OR "Insulin-Dependent Diabetes Mellitus" OR "Diabetes Mellitus, Juvenile-Onset" OR "Diabetes Mellitus, Juvenile Onset" OR "Juvenile-Onset Diabetes Mellitus" OR IDDM OR "Type 1 Diabetes Mellitus" OR "Insulin-Dependent Diabetes Mellitus 1" OR "Insulin Dependent Diabetes Mellitus 1" OR "Juvenile-Onset Diabetes" OR "Diabetes, Juvenile-Onset" OR "Juvenile Onset Diabetes") **#4 Cardiorespiratory Fitness:** TX ("Cardiorespiratory Fitness" OR "Fitness, Cardiorespiratory" OR "Exercise Capacity" OR "Functional Capacity" OR "Vo2max" OR "Maximum O2 Consumption" OR "Maximum Oxygen Consumption" OR "Vo2peak" OR "Peak O2 Consumption" OR "Peak Oxygen Consumption" OR "Aerobic Capacity") **Search:** (#1 OR #2) AND #3 AND #4		
LILACS	**LANGUAGE:** English **#1 Child:** (Child OR Children) **#2 Adolescent:** (Adolescent OR Adolescents OR Adolescence OR Youth OR Youths OR Teens OR Teen OR Teenagers OR Teenager) **#3 Diabetes Mellitus, Type 1:** ("Diabetes Mellitus, Type 1" OR **"**Type 1 Diabetes" OR "Diabetes, Type 1" OR "Diabetes Mellitus, Insulin-Dependent" OR "Diabetes Mellitus, Insulin Dependent" OR "Insulin-Dependent Diabetes Mellitus" OR "Diabetes Mellitus, Juvenile-Onset" OR "Diabetes Mellitus, Juvenile Onset" OR "Juvenile-Onset Diabetes Mellitus" OR IDDM OR "Type 1 Diabetes Mellitus" OR "Insulin-Dependent Diabetes Mellitus 1" OR "Insulin Dependent Diabetes Mellitus 1" OR "Juvenile-Onset Diabetes" OR "Diabetes, Juvenile-Onset" OR "Juvenile Onset Diabetes") **#4 Cardiorespiratory Fitness:** ("Cardiorespiratory Fitness" OR "Fitness, Cardiorespiratory") **Search:** (#1 OR #2) AND #3 AND #4	19/09/2024	0
	LANGUAGE: Spanish **#1 Niño:** (Niño OR Niños) **#2 Adolescente:** (Adolescente OR Adolescents OR Adolescencia OR Joven OR Jóvenes OR Juventud) **#3 Diabetes Mellitus Tipo 1:** ("Diabetes Mellitus Tipo 1" OR "Diabetes Mellitus 1 Insulinodependiente" OR "Diabetes Mellitus Insulino-Dependiente" OR "Diabetes Mellitus Insulinodependiente" OR	19/09/2024	2

	"Diabetes Mellitus Juvenil Inicial" OR "Diabetes Tipo 1" OR DMID) **#4 Capacidad Cardiovascular:** ("Capacidad Cardiovascular" OR "Resistencia Cardiovascular") **Search:** (#1 OR #2) AND #3 AND #4		
	LANGUAGE: Portuguese **#1 Criança:** (Criança OR Crianças) **#2 Adolescente:** (Adolescente OR Adolescentes OR Adolescência OR Jovem OR Jovens OR Juventude) **#3 Diabetes Mellitus Tipo 1:** ("Diabetes Mellitus Tipo 1" OR "Diabetes do Tipo 1" OR "Diabetes Mellitus 1 Dependente de Insulina" OR "Diabetes Mellitus de Início na Juventude" OR "Diabetes Mellitus Insulinodependente" OR "Diabetes Mellitus Tipo I" OR "Diabetes Tipo 1" OR DMID) **#4 Aptidão Cardiorrespiratória:** "Aptidão Cardiorrespiratória" **Search:** (#1 OR #2) AND #3 AND #4	19/09/2024	9

Search strategies applied in gray literature and unpublished studies

DATABASE	SEARCH STRATEGY	DATE	RESULTS
ProQuest (Clarivate)	**#1 Child:** Child **#2 Adolescent:** Adolescent **#3 Diabetes Mellitus, Type 1:** "Diabetes Mellitus, Type 1" **#4 Cardiorespiratory Fitness:** "Cardiorespiratory Fitness" **#Filters:** Periódicos acadêmicos; Dissertações e teses **Search:** (abstract(Child) OR title(Child) OR abstract(Adolescent) OR title(Adolescent)) AND abstract("Diabetes Mellitus, Type 1") OR title("Diabetes Mellitus, Type 1") AND abstract("Cardiorespiratory Fitness") OR title("Cardiorespiratory Fitness")	20/09/2024	565
Catálogo de Teses e Dissertações (CAPES)	**#1 Diabetes Mellitus Tipo 1:** Diabetes Mellitus Tipo 1 **#2 Aptidão Cardiorrespiratória:** Aptidão Cardiorrespiratória **Search:** #1 E #2	20/09/2024	2
Clinical Trials	**#1 Diabetes Mellitus, Type 1:** Diabetes Mellitus Type 1	20/09/2024	7

(NCBI)	**#2 Cardiorespiratory Fitness:** Cardiorespiratory Fitness **Search:** #1 AND #2		

SI4. List of excluded references with reasons

	Author, year	Reference	Reason for exclusion
1	Alvares TS *et al,* 2024	Alvares TS, de Sousa LVM, Soares RN, Lessard SJ. Cardiorespiratory Fitness Is Impaired in Type 1 and Type 2 Diabetes: A Systematic Review, Meta-Analysis, and Meta-Regression. Med Sci Sports Exerc. 2024;56(9):1553-62.	Wrong population
2	De Visser HS *et al.*, 2024	De Visser HS, Fast I, Brunton N, Arevalo E, Askin N, Rabbani R, et al. Cardiorespiratory Fitness and Physical Activity in Pediatric Diabetes: A Systemic Review and Meta-Analysis. JAMA Network Open. 2024;7(2):e240235-e.	Wrong outcome
3	Murillo S *et al.*, 2024	Murillo S, Brugnara L, Ríos S, Ribas V, Servitja JM, Novials A. People with type 1 diabetes exhibit lower exercise capacity compared to a control population with similar physical activity levels. Diabetes Res Clin Pract. 2024;211:111655.	Wrong population
4	Nazari M *et al.,* 2024	Nazari M, Minasian V. The impact of organized exercise and non-organized leisured time activity on serum pentraxin3 and C-reactive protein levels, lipid profile and physical fitness in diabetic children. *Asian* J Sports Med. 2024 Jun;15(2)	Wrong outcome

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		capacity, physical activity level and glycemic control of teenagers with diabetes mellitus type 1: a cross-sectional study. *Horm Res Pediatric.* 2010;74(0):9.	type
97	Rosa JS *et al.,* 2009	Rosa JS, Flores RL, Pontello A, Bachman G, Zaldivar FP, Galassetti PR. Prior hyperglycemia increases interleukin-6 levels at rest and following exercise in type 1 diabetic children. *Diabetes.* 2009;58(0).	Wrong publication type
98	Rosa JS *et al.,* 2009	Rosa JS, Heydari S, Oliver SR, Flores RL, Pontello A, Galassetti PR. Kinetics of 8 inflammatory cytokines during exercise in obese, diabetic, and healthy children. *Diabetes.* 2009;58(0).	Wrong publication type
99	Gusso S *et al.*, 2008	Gusso S, Hofman P, Lalande S, Cutfield W, Robinson E, Baldi JC. Impaired stroke volume and aerobic capacity in female adolescents with type 1 and type 2 diabetes mellitus. Diabetologia. 2008;51(7):1317-20.	Wrong outcome
100	Ramalho ACR *et al.,* 2008	Ramalho ACR, Soares S. O papel do exercício no tratamento do diabetes melito tipo 1. Arquivos Brasileiros de Endocrinologia & Metabologia. 2008;52.	Wrong study design
101	Guelfi KJ *et al.*, 2007	Guelfi KJ, Ratnam N, Smythe GA, Jones TW, Fournier PA. Effect of intermittent high-intensity compared with continuous moderate exercise on glucose production and utilization in individuals with type 1 diabetes. Am J Physiol Endocrinol Metab. 2007;292(3):E865-70.	Wrong population

102	Wallymahmed ME *et al.,* 2007	Wallymahmed ME, Morgan C, Gill GV, Macfarlane IA. Aerobic fitness and hand grip strength in type 1 diabetes: relationship to glycaemic control and body composition. *Diabet Med.* 2007;24(11):1296–9.	Wrong population
103	Galassetti PR *et al.*, 2006	Galassetti PR, Iwanaga K, Crisostomo M, Zaldivar FP, Larson J, Pescatello A. Inflammatory cytokine, growth factor and counterregulatory responses to exercise in children with type 1 diabetes and healthy controls. Pediatr Diabetes. 2006;7(1):16-24.	Wrong outcome
104	Sideraviciūte S *et al.,* 2006	Sideraviciūte S, Gailiūniene A, Visagurskiene K, Vizbaraite D. The effect of long-term swimming program on body composition, aerobic capacity and blood lipids in 14-19-year aged healthy girls and girls with type 1 diabetes mellitus. Medicina (Kaunas). 2006;42(8):661-6.	Wrong population
105	Faulkner MS *et al.,* 2005	Faulkner MS, Quinn L, Rimmer JH, Rich BH. Cardiovascular endurance and heart rate variability in adolescents with type 1 or type 2 diabetes. Biol Res Nurs. 2005;7(1):16-29.	Wrong population
106	Komatsu WR *et al.*, 2005	Komatsu WR, Gabbay MA, Castro ML, Saraiva GL, Chacra AR, de Barros Neto TL, et al. Aerobic exercise capacity in normal adolescents and those with type 1 diabetes mellitus. Pediatr Diabetes. 2005;6(3):145-9.	Wrong population
107	Roberts L *et al.,* 2002	Roberts L, Jones TW, Fournier PA. Exercise training and glycemic control	Wrong outcome

		in adolescents with poorly controlled type 1 diabetes mellitus. J Pediatr Endocrinol Metab. 2002;15(5):621-7.	
108	Rabasa-Lhoret R *et al.*, 2001	Rabasa-Lhoret R, Burelle Y, Ducros F, Bourque J, Lavoie C, Massicotte D, et al. Use of an alpha-glucosidase inhibitor to maintain glucose homoeostasis during postprandial exercise in intensively treated Type 1 diabetic subjects. Diabet Med. 2001;18(9):739-44.	Wrong population
109	Riddell MC *et al*., 2000	Riddell MC, Bar-Or O, Gerstein HC, Heigenhauser GJ. Perceived exertion with glucose ingestion in adolescent males with IDDM. Med Sci Sports Exerc. 2000;32(1):167-73.	Wrong population
110	Rigla M *et al.*, 2000	Rigla M, Sánchez-Quesada JL, Ordóñez-Llanos J, Prat T, Caixàs A, Jorba O, et al. Effect of physical exercise on lipoprotein(a) and low-density lipoprotein modifications in type 1 and type 2 diabetic patients. Metabolism. 2000;49(5):640-7.	Wrong population
111	McKewen MW *et al.,* 1999	McKewen MW, Rehrer NJ, Cox C, Mann J. Glycaemic control, muscle glycogen and exercise performance in IDDM athletes on diets of varying carbohydrate content. Int J Sports Med. 1999;20(6):349-53.	Wrong population
112	Estacio RO *et al.*, 1998	Estacio RO, Regensteiner JG, Wolfel EE, Jeffers B, Dickenson M, Schrier RW. The association between diabetic complications and exercise capacity in NIDDM patients. Diabetes Care. 1998;21(2):291-5.	Wrong population

113	King P *et al.*, 1998	King P, Kong MF, Parkin H, Macdonald IA, Tattersall RB. Well-being, cerebral function, and physical fatigue after nocturnal hypoglycemia in IDDM. Diabetes Care. 1998;21(3):341-5.	Wrong outcome
114	Mosher PE *et al.*, 1998	Mosher PE, Nash MS, Perry AC, LaPerriere AR, Goldberg RB. Aerobic circuit exercise training: effect on adolescents with well-controlled insulin-dependent diabetes mellitus. Arch Phys Med Rehabil. 1998;79(6):652-7.	Wrong outcome
115	Dunstan DW *et al.*, 1997	Dunstan DW, Mori TA, Puddey IB, Beilin LJ, Burke V, Morton AR, et al. The independent and combined effects of aerobic exercise and dietary fish intake on serum lipids and glycemic control in NIDDM. A randomized controlled study. Diabetes Care. 1997;20(6):913-21.	Wrong population
116	Dyson PA *et al.*, 1997	Dyson PA, Hammersley MS, Morris RJ, Holman RR, Turner RC. The Fasting Hyperglycaemia Study: II. Randomized controlled trial of reinforced healthy-living advice in subjects with increased but not diabetic fasting plasma glucose. Metabolism. 1997;46(12 Suppl 1):50-5.	Wrong population
117	Estacio RO *et al.*, 1996	Estacio RO, Wolfel EE, Regensteiner JG, Jeffers B, Havranek EP, Savage S, et al. Effect of Risk Factors on Exercise Capacity in NIDDM. Diabetes. 1996;45(1):79-85.	Wrong population
118	Rychlewski T *et al.,*	Rychlewski T, Szcześniak L. Fructosamine in blood serum, binding and	Wrong outcome

	1996	degradation of 125J-insulin by erythrocyte receptors in young persons with type I diabetes-effect of physical exercise. Pol Arch Med Wewn. 1996;95(3):212-7.	
119	Soo K *et al.*, 1996	Soo K, Furler SM, Samaras K, Jenkins AB, Campbell LV, Chisholm DJ. Glycemic responses to exercise in IDDM after simple and complex carbohydrate supplementation. Diabetes Care. 1996;19(6):575-9.	Wrong population
120	Devlin JT *et al.,* 1994	Devlin JT, Scrimgeour A, Brodsky I, Fuller S. Decreased protein catabolism after exercise in subjects with IDDM. Diabetologia. 1994;37(4):358-64.	Wrong outcome
121	Lucja S *et al.*, 1993	Lucja S, Franciszek B, Tadeusz R, Mieczysław W, Jerzy G. Binding and degradation of 125I insulin of erythrocyte receptors--effect of physical exertion. Endokrynol Pol. 1993;44(2):137-45.	Wrong outcome
122	Schneider SH *et al.*, 1992	Schneider SH, Khachadurian AK, Amorosa LF, Clemow L, Ruderman NB. Ten-year experience with an exercise-based outpatient life-style modification program in the treatment of diabetes mellitus. Diabetes Care. 1992;15(11):1800-10.	Wrong population
123	Arslanian S *et al.,* 1990	Arslanian S, Nixon PA, Becker D, Drash AL. Impact of physical fitness and glycemic control on in vivo insulin action in adolescents with IDDM. Diabetes Care. 1990;13(1):9-15.	Wrong population

124	Huttunen NP *et al.*, 1989	Huttunen NP, Länkelä SL, Knip M, Lautala P, Käär ML, Laasonen K, et al. Effect of once-a-week training program on physical fitness and metabolic control in children with IDDM. Diabetes Care. 1989;12(10):737-40.	Wrong outcome
125	Jensen T *et al.*, 1988	Jensen T, Richter EA, Feldt-Rasmussen B, Kelbaek H, Deckert T. Impaired aerobic work capacity in insulin dependent diabetics with increased urinary albumin excretion. Br Med J (Clin Res Ed). 1988;296(6633):1352-4.	Wrong population
126	Marrero DG *et al.,* 1988	Marrero DG, Fremion AS, Golden MP. Improving compliance with exercise in adolescents with insulin-dependent diabetes mellitus: results of a self-motivated home exercise program. Pediatrics. 1988;81(4):519-25.	Wrong outcome
127	Fremion AS *et al.,* 1987	Fremion AS, G. MD, and Golden MP. Maximum Oxygen Uptake Determination in Insulin-Dependent Diabetes Mellitus. The Physician and Sportsmedicine. 1987;15(7):118-26.	wrong outcome
128	Wallberg-Henriksson H *et al.*, 1986	Wallberg-Henriksson H, Gunnarsson R, Rössner S, Wahren J. Long-term physical training in female type 1 (insulin-dependent) diabetic patients: absence of significant effect on glycaemic control and lipoprotein levels. *Diabetologia.* 1986;29(1):53–7.	Wrong population

129	Campaigne BN *et al.*, 1984	Campaigne BN, Gilliam TB, Spencer ML, Lampman RM, Schork MA. Effects of a physical activity program on metabolic control and cardiovascular fitness in children with insulin-dependent diabetes mellitus. Diabetes Care. 1984;7(1):57-62.	Wrong outcome

SI5. List of authors contacted, data requested, means of communication used, authors responses and decisions made

Author, year	Requested data	Media	Answer / Decision
Saki H *et al.*, 2023	Access to full text in English	-	The data could not be obtained / The paper was excluded
Miadovnik LA *et al.*, 2013	Access to full text	E-mail and ResearchGate	The authors did not answer the message / The paper was excluded
Heyman E *et al.*, 2006	Access to full text	E-mail and ResearchGate	The authors did not answer the message / The paper was excluded

ANEXO A – Normas da revista

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Please use double-spaced text, page numbering (starting with the title page) and line numbering.

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ANEXO B – Comprovante de submissão do artigo

Gmail Luis Fernando Deresz

SPOA-D-25-00918 - Submission Confirmation

1 mensagem

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Para: Luis Fernando Deresz

<lfderesz@gmail.com> Dear Dr

Deresz,

Thank you for submitting your manuscript, "Cardiorespiratory fitness in children and adolescents with type 1 diabetes: key factors from a scoping review", to Sports Medicine

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