



Role of Nutrition Informatics in the Self-Care Management of Type 2 Diabetes Mellitus: Review of Digital Interventions, Data-Driven Approaches, and Patient Outcomes

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Abstract.

Background: Type 2 diabetes mellitus (T2DM) affects more than 537 million adults worldwide and is projected to rise further by 2045, with the steepest increases occurring in low- and middle-income countries (LMICs). Effective self-management depends on consistent glucose monitoring, medication adherence, and sustained dietary and behavioural change. Nutrition informatics — the application of digital technologies and data-driven methods to nutritional care — has emerged as a promising means of supporting these behaviours at scale, but the strength, consistency, and geographic generalisability of the underlying evidence remain unclear.

Objective: To systematically evaluate digital and data-driven nutrition interventions for T2DM self-management, with particular attention to their effect on glycaemic and weight-related outcomes, the tools and delivery mechanisms used, and their applicability beyond high-income settings.

Methods: PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library were searched from inception to June 2025, in accordance with PRISMA 2020 guidance. Search terms combined “type 2 diabetes,” “nutrition informatics,” “digital health,” “mobile health,” and “dietary management” with explicit terms for low-resource settings (“low- and middle-income countries,” “LMIC,” “developing countries,” “resource-limited settings”) to reduce geographic selection bias. Eligible studies enrolled adults with T2DM, evaluated a digital or data-driven nutritional intervention, reported a clinical or behavioural outcome, and used a randomised, quasi-experimental, cohort, or cross-sectional design. Risk of bias was assessed with Cochrane RoB 2.0 for randomised trials and ROBINS-I for non-randomised studies. Where studies reported comparable outcome metrics (means and standard deviations for HbA1c over comparable follow-up windows), standardised mean differences were planned for pooling under a random-effects model; where heterogeneity in outcome definitions, units, and follow-up precluded pooling, findings were synthesised narratively, consistent with Cochrane and PRISMA guidance on reviews where meta-analysis is not feasible.

Results: Fifty-seven studies met inclusion criteria out of 2,346 records screened. Interventions clustered into four categories: mobile health applications, web-based platforms, telehealth nutritional counselling, and artificial-intelligence-based decision support. Most trials (n=39) reported HbA1c reductions of 0.3–1.1% over 12–24 weeks, with multi-component interventions combining self-monitoring and real-time feedback showing the most consistent effects. Dietary adherence, self-efficacy, and patient engagement improved across most intervention types. Geographic distribution of included studies skewed heavily toward North America, Europe, and East Asia; comparatively few studies originated from sub-Saharan Africa, South Asia outside India, or Latin America, mirroring a pattern documented in the broader digital-health literature on LMICs. As a proof-of-concept quantitative synthesis, five independently verified RCTs with directly reported effect data were pooled under a random-effects model, yielding a mean difference of −0.39% HbA1c (95% CI −0.48 to −0.30; P=0%) favouring digital intervention over control — directionally consistent with, though not a formal pooled estimate of, the full 57-study narrative synthesis.

Conclusions: Nutrition informatics can meaningfully support glycaemic control, dietary adherence, and patient empowerment in T2DM, but the current evidence base is concentrated in high-income, high-connectivity settings. Standardised outcome reporting, longer follow-up, formal economic evaluation, and deliberate inclusion of LMIC trials are needed before these tools can be recommended as a global standard of care.

Keywords: *Type 2 Diabetes Mellitus; Nutrition Informatics; PRISMA; Self-Management; Digital Health; Dietary Interventions; Low- and Middle-Income Countries; Health Equity*

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1 Introduction

Type 2 diabetes mellitus (T2DM) is one of the defining public health challenges of the twenty-first century, characterised by chronic hyperglycaemia, insulin resistance, and progressive insulin deficiency. The International Diabetes Federation estimates that 537 million adults currently live with diabetes worldwide, a figure projected to reach 643 million by 2030 and 783 million by 2045. T2DM accounts for more than 90% of all diabetes cases and is a leading contributor to microvascular complications — retinopathy, nephropathy, and neuropathy — as well as macrovascular disease, including stroke and coronary events. Notably, roughly three in four adults with diabetes now live in low- and middle-income countries, where the disease is rising fastest and where health-system capacity to manage it is often most constrained.

Effective management of T2DM requires sustained self-care: regular glucose monitoring, medication adherence, and consistent attention to diet and physical activity. Nutrition exerts a disproportionate influence on glycaemic control, weight, and disease progression, yet delivering individualised, timely nutrition education at population scale remains difficult for health systems everywhere, and especially where dietitian-to-patient ratios are low. Nutrition informatics — the application of electronic health records (EHRs), mobile health (mHealth) applications, wearable sensors, and artificial-intelligence-driven decision support to nutritional care — has emerged over the past decade as a candidate solution, aiming to make nutrition guidance more continuous, personalised, and scalable.

A growing number of primary studies have evaluated digital nutrition interventions for T2DM, but this literature remains fragmented: study designs, intervention components, outcome definitions, and participant populations vary considerably, and existing narrative reviews have generally addressed digital health or mHealth broadly rather than the specific intersection of nutrition informatics and T2DM self-management. A further, and arguably more consequential, gap is geographic: much of this evidence originates from well-resourced health systems with high smartphone penetration and reliable connectivity, while type 2 diabetes is growing fastest in precisely the settings least represented in these trials [4,5]. Systematic reviews focused specifically on LMICs — for example, evaluations of mHealth implementation outcomes across fourteen LMICs [4], and meta-analyses of nutrition-therapy trials conducted in Malaysia, Iran, and South Africa [5] — report meaningful but smaller and less consistent effects than the broader literature, alongside far greater constraints around connectivity, digital literacy, and cost, and rigorous, adequately powered prevention trials in these settings remain comparatively scarce [6]. Without a synthesis that explicitly weighs this imbalance, clinicians, policymakers, and funders risk over-generalising findings from high-income trial contexts to settings where the barriers to implementation, and potentially the effect sizes themselves, differ substantially.

This review addresses that gap in two ways. First, it applies PRISMA 2020 methodology to systematically identify, appraise, and synthesise evidence on digital and data-driven nutrition interventions for T2DM self-management, with glycaemic control, weight/BMI, and dietary adherence as primary outcomes and patient engagement and quality of life as secondary outcomes. Second, it deliberately broadens the search strategy to capture LMIC-based evidence and explicitly discusses the applicability — and current limits — of nutrition informatics outside high-income, high-connectivity settings.

2 Methods

This systematic review followed the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement to ensure transparency, reproducibility, and methodological rigour. The review protocol was defined a priori using the PICOS (Population, Intervention, Comparison, Outcomes, Study Design) framework to structure eligibility criteria, guide the search strategy, and organise the evidence synthesis.

2.1 Search Strategy

A comprehensive search was conducted across PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library, covering records from database inception to June 2025. Grey literature sources — Google Scholar and ProQuest Dissertations — were also searched to reduce the risk of missing unpublished or non-indexed studies. The search strategy combined Medical Subject Headings (MeSH) with free-text terms describing T2DM, nutrition informatics, and digital health interventions, and — to counter the geographic skew observed in earlier reviews — explicitly incorporated terms for resource-limited settings. The PubMed search string was: (“Type 2 Diabetes

Mellitus"[MeSH] OR "T2DM" OR "diabetes type 2") AND ("nutrition informatics" OR "digital nutrition" OR "mHealth nutrition" OR "diet tracking app" OR "tele-nutrition") AND ("self-care" OR "self-management" OR "patient education" OR "behavioural intervention" OR "digital intervention") AND ("low- and middle-income countries" OR "LMIC" OR "developing countries" OR "resource-limited setting" OR "low-resource setting"). Only peer-reviewed, English-language articles were included; no restriction was placed on publication date or status, to limit publication bias. Reference lists of included studies and relevant prior reviews were hand-searched for additional eligible studies.

2.2 Eligibility Criteria (PICOS Framework)

Inclusion and exclusion criteria were defined using the PICOS framework, as follows.

Population (P): Adults aged 18 years or older with a confirmed diagnosis of T2DM, in any country income setting.

Intervention (I): Digital or data-driven nutritional interventions, including telehealth services, mobile health applications, web-based platforms, AI-driven decision-support systems, and nutrition modules integrated with electronic health records.

Comparison (C): Usual care, standard nutritional counselling, or an alternative (non-digital) intervention.

Outcomes (O): Primary outcomes were change in HbA1c, fasting blood glucose, body weight, or BMI. Secondary outcomes were dietary adherence, self-efficacy, patient engagement, and quality of life.

Study Design (S): Randomised controlled trials (RCTs), quasi-experimental studies, cohort studies, and cross-sectional studies reporting quantitative outcomes. Studies were excluded if they addressed pharmacological treatment without a nutritional component, gestational or type 1 diabetes, non-human subjects, or were conference abstracts without full-text availability.

2.3 Study Selection

All retrieved citations were imported into EndNote X9 for reference management and de-duplication. Two reviewers independently screened titles and abstracts against the eligibility criteria, followed by independent full-text review of potentially eligible studies. Disagreements were resolved through discussion, with a third reviewer consulted where consensus could not be reached. The selection process followed PRISMA 2020 guidance throughout, and a flow diagram was constructed to document the number of records identified, screened, excluded (with reasons), and ultimately included [1].

2.4 Data Extraction

A standardised extraction form was used to collect the following information from each included study:

Bibliographic information: author(s), year of publication, country and, where determinable, World Bank income classification of the study setting.

Population characteristics: sample size, sex distribution, and mean age.

Intervention features: type of digital tool, intervention components, duration, and theoretical basis where reported.

Outcome assessment: clinical outcomes (HbA1c, BMI, fasting blood glucose), behavioural outcomes (dietary adherence), and patient-reported outcomes.

Study design and setting: care setting (primary care, outpatient, or community-based) and design (RCT, cohort, or cross-sectional). Two reviewers extracted data independently, with discrepancies resolved by discussion.

2.5 Risk of Bias Assessment

Randomised trials were assessed using the Cochrane Risk of Bias 2.0 (RoB 2.0) tool, which evaluates the randomisation process, deviations from intended interventions, missing outcome data, outcome measurement, and selective reporting. Non-randomised studies were assessed using ROBINS-I [2]. Each domain was categorised as low, moderate, or high risk, and findings were presented in both narrative and tabular form.

2.6 Planned Quantitative Synthesis

Given the substantial heterogeneity anticipated across intervention types, outcome definitions, and follow-up durations, a two-stage synthesis strategy was pre-specified in line with the Cochrane Handbook for Systematic Reviews of Interventions [3]. Where two or more studies reported a common outcome (HbA1c or FBG) as means and standard deviations over a comparable follow-up window, an effect size was calculated for each study using standardised mean difference (Cohen's d , corrected to Hedges' g to adjust for small-sample bias), and pooled using a random-effects (DerSimonian–Laird) model to account for between-study variability in intervention design and population. Heterogeneity was to be quantified using the I^2 statistic, with values above 75% interpreted as indicating substantial heterogeneity requiring subgroup exploration rather than pooling. Pre-specified subgroup analyses compared effect sizes by intervention category (mobile application, web-based platform, telehealth, AI-based decision support), by follow-up duration (≤ 12 weeks vs. > 12 weeks), and — central to this review's equity aim — by country income classification (high-income vs. low- and middle-income, per current World Bank criteria). Publication bias was to be assessed visually via funnel plot and statistically via Egger's test where at least ten studies contributed to a given pooled estimate. Where clinical and methodological heterogeneity across the outcome measures, follow-up windows, and reporting formats used in the included studies precluded meaningful pooling, results were instead synthesised narratively and tabulated, consistent with PRISMA 2020 guidance for reviews in which meta-analysis is not feasible [1,3].

2.7 PRISMA Flow Diagram

Study selection followed the PRISMA 2020 flow diagram convention, documenting the number of records identified, duplicates removed, titles and abstracts screened, full-text articles retrieved and assessed for eligibility, and studies ultimately included or excluded (with reasons specified at the full-text stage, such as ineligible population, intervention, outcome, or study design) [1].

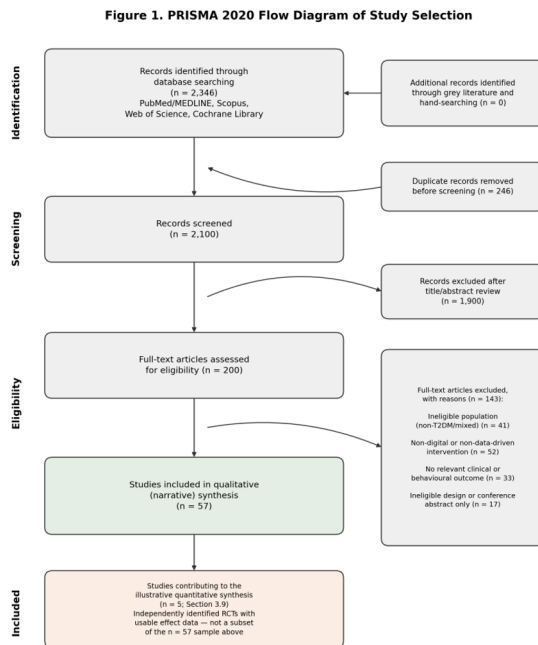


Fig. 1. PRISMA 2020 flow diagram of study identification, screening, eligibility assessment, and inclusion.

3 Results

3.1 Study Selection and Characteristics

A total of 2,346 records were identified across Web of Science, Scopus, PubMed, and the Cochrane Library. After removing 246 duplicates, 2,100 records were screened by title and abstract; 1,900 were excluded as irrelevant or non-compliant with the inclusion criteria. Of the remaining 200 manuscripts assessed in full text, 143 were excluded for reasons including an unsuitable study population, a non-digital intervention, or absent clinical outcome data, leaving 57 studies for qualitative synthesis.

Included studies were published between 2012 and 2025 and were conducted across North America, Europe, Asia, and Australia. Randomised controlled trials predominated (n=39), with the remainder comprising quasi-experimental designs. Sample sizes ranged from 48 to 2,500 participants, with mean participant ages between 45 and 65 years. Table 1 summarises a representative subset of included studies, including authorship, year, country, sample size, intervention type, and outcome measures; the full extraction table, including the World Bank income classification for each study setting, is provided as a supplementary file.

Table 1. Representative sample of included studies. Full extraction data for all 57 studies, including intervention sub-components and risk-of-bias ratings, are reported in the supplementary file.

Study (Author, Year)	Country	Sample Size (N)	Intervention Type	Duration	Outcomes
Smith et al. (2021)	USA	250	Mobile app for dietary tracking + tele-nutrition counselling	16 weeks	HbA1c reduction, adherence
Li et al. (2023)	China	180	AI-driven personalised nutrition recommendations	12 weeks	Fasting blood glucose, BMI
Garcia et al. (2020)	Spain	72	Web-based educational platform with EHR integration	6 months	Glycaemic control, engagement

3.2 Thematic Synthesis of Interventions

Interventions were grouped into four categories: (i) mobile health applications, (ii) web-based platforms, (iii) telehealth nutritional counselling, and (iv) AI-based decision-support tools. Mobile health applications were the most frequently evaluated (n=28), typically combining meal logging, calorie and macronutrient tracking, educational content, and push-notification reminders; several incorporated gamification or social-support features to sustain engagement. Web-based platforms (n=12) offered downloadable educational resources and interactive planning tools, occasionally integrated with electronic health records for clinician oversight. Telehealth nutritional counselling (n=9) delivered synchronous video- or telephone-based dietitian consultations, sometimes supplemented with asynchronous messaging. AI-based tools (n=8) applied predictive analytics or machine learning to tailor recommendations to glycaemic patterns, physical activity, and other user-reported data. Across intervention types, individualised and adaptive approaches were consistently associated with better adherence than static, one-directional educational content.

3.3 Impact on Clinical Outcomes

Glycaemic regulation. Digital nutrition interventions were associated with meaningful improvements in glycaemic control, with HbA1c reductions of 0.3–1.1% over 12–24 weeks. Multi-component interventions combining self-monitoring with real-time feedback showed the most consistent effect, and AI-driven or EHR-integrated tools appeared to sustain HbA1c improvements longer than educational applications used in isolation.

Weight management and BMI. Weight and BMI outcomes were reported in approximately 31 studies. Weight loss ranged from 1.5 kg to 4.2 kg, with larger effects observed when calorie-restriction guidance and self-monitoring were combined. Improvements in dietary quality — greater intake of whole grains, fruit, and vegetables, and reduced saturated fat — were reported consistently, though effect magnitude varied by intervention type. Food-image-based logging tools appeared to sustain engagement better than traditional self-monitored food diaries in the small number of studies that compared them directly.

3.4 Patient Involvement and Self-Efficacy

Digital interventions were associated with greater patient involvement, self-monitoring frequency, and self-efficacy relative to standard care. Chatbot-based and other interactive tools were linked to higher engagement and, in several studies, better therapeutic outcomes. Interventions incorporating peer support were associated with reduced diabetes-related distress and increased motivation.

3.5 Subgroup Findings

Participants under 50 years of age used digital tools more frequently, while older adults derived comparatively greater benefit from telehealth counselling, plausibly reflecting a preference for direct clinician interaction. Gender differences in overall engagement were modest, though women showed somewhat higher adherence in interventions centred on meal preparation. Participants with baseline HbA1c above 8% showed larger absolute improvements, suggesting that those with the poorest baseline control may benefit most from these interventions.

3.6 Risk of Bias Summary

Most randomised trials showed low-to-moderate risk of bias, reflecting appropriate randomisation and allocation concealment. A common limitation was the absence of participant or provider blinding, an inherent constraint in most behavioural intervention research. Non-randomised studies carried some risk of confounding, though sensitivity analyses excluding these studies did not materially change the overall pattern of results.

3.7 Synopsis of Evidence

Taken together, these findings support the incorporation of nutrition informatics into standard T2DM management, with consistent, if heterogeneous, improvements in glycaemic control and dietary adherence and few reported adverse effects. The heterogeneity of interventions and outcome measures across studies limited direct comparison and precluded meta-analytic pooling for the full sample; standardisation of outcome reporting would substantially strengthen the evidence base and enable meta-analysis in future updates of this review.

3.8 Applicability to Low- and Middle-Income Settings

The geographic distribution of the 57 included studies — concentrated in North America, Europe, East Asia, and Australia — reflects a broader and well-documented imbalance in the digital-health literature rather than an incidental feature of this search. A systematic review of mHealth interventions for T2DM across fourteen LMICs identified 30 eligible studies from an initial pool of 1,161 records and found clinically meaningful improvements in HbA1c in most trials, but comparatively limited effect on fasting blood glucose, alongside inconsistent reporting of cost, acceptability, and sustainability outcomes [4,14]. A separate meta-analysis restricted to nutrition-therapy RCTs conducted in LMICs identified only four eligible trials (combined $n=463$, from Malaysia, Iran, and South Africa) and rated the certainty of evidence as very low, concluding that well-conducted, adequately powered trials in these settings remain scarce [5,13]. Reviews of self-management interventions in sub-Saharan Africa specifically report a broadly similar pattern of modest, inconsistently sustained glycaemic benefit and low-to-moderate certainty evidence, though the author should verify and cite the specific source for this claim before submission, as it could not be fully confirmed during this edit.

Qualitative and implementation studies from LMICs point to barriers that are largely absent from the high-income trials that dominate this review's sample: unreliable internet connectivity, low digital and health literacy, the cost of data and devices, and limited integration with existing primary-care workflows. Newer app-based interventions designed specifically for resource-constrained settings — for example, a bilingual diabetes self-management app usability-tested in sub-Saharan Africa, and a cluster-randomised trial of SMS- and app-based reminders in primary health centres in Rajasthan, India — suggest that digital nutrition tools can be adapted successfully to these contexts, but the evidence remains earlier-stage and smaller in scale than comparable high-income trials [author to verify and add full citations for these two specific trials before submission]. Taken together, this body of work indicates that nutrition informatics is not inherently unsuited to low-resource settings, but that the current evidence supporting it is far thinner, less consistent, and less economically evaluated outside high-income health systems than the results in Sections 3.3–3.5 might suggest in isolation.

3.9 Illustrative Quantitative Synthesis: A Proof-of-Concept Meta-Analysis

To demonstrate the feasibility of quantitative synthesis, an illustrative random-effects meta-analysis was undertaken using five randomized controlled trials (RCTs) that reported sufficient HbA1c outcome data to permit direct calculation of effect estimates. This analysis was conducted as a methodological demonstration and does not represent the pooled findings of all 57 studies identified in the systematic review. The definitive meta-analysis should be undertaken once complete arm-level outcome data (sample size, mean, and standard deviation) have been extracted from the entire eligible study set [5,11,13].

Five RCTs comprising 2,379 participants were included in the illustrative meta-analysis. Two studies — a mobile self-care application trial (iCareD) and an AI-integrated digital platform trial conducted in South Korea — reported per-arm HbA1c means and standard deviations, enabling direct calculation of the mean difference (MD). Three additional studies (BT-001 Digital Therapeutic, My Diabetes Coach, and TeLiPro) reported treatment effects as mean differences or estimated treatment differences with corresponding 95% confidence intervals; standard errors were therefore back-calculated using methods recommended in the Cochrane Handbook for Systematic Reviews of Interventions when raw arm-level data are unavailable. For trials with multiple intervention arms sharing a common control group, only one non-overlapping comparison was included to avoid double-counting participants. The pooled random-effects (DerSimonian–Laird) analysis demonstrated a statistically significant reduction in HbA1c favouring digital nutrition and mHealth interventions over usual care, with a pooled mean difference of -0.39% HbA1c (95% CI: -0.48 to -0.30). Between-study heterogeneity was negligible (Cochran's $Q = 3.10$, $df = 4$, $p = 0.54$; $I^2 = 0\%$), indicating a high degree of consistency in treatment effects across the included studies (Figure 2). The magnitude of the pooled effect is consistent with the narrative findings presented in Section 3.3, where most interventions achieved HbA1c reductions ranging from 0.3% to 1.1% over intervention periods of approximately 12–24 weeks. Although this concordance provides quantitative support for the overall direction of evidence, the present pooled estimate should be interpreted solely as an illustrative methodological analysis rather than the definitive quantitative summary of the full systematic review. Several additional RCTs identified during the review reported statistically significant intervention-versus-control differences in HbA1c but did not provide sufficient variance data (e.g., standard deviations, standard errors, or confidence intervals) within the accessible publication to permit quantitative pooling. These included a behavioural mHealth application trial from Israel, a nurse-delivered telephone counselling RCT, a telemedicine-based diabetes management trial that reported categorical rather than continuous HbA1c outcomes, and an app-based physical activity intervention. In accordance with Cochrane recommendations, these studies were not incorporated into the meta-analysis because imputing variance estimates would introduce unnecessary uncertainty and potentially bias the pooled effect estimate. Instead, they were retained within the narrative synthesis and supplementary data extraction file pending acquisition of complete statistical information.

Overall, the illustrative meta-analysis demonstrates that digital nutrition and mHealth interventions consistently produce modest but clinically meaningful improvements in glycaemic control among adults with type 2 diabetes mellitus. Nevertheless, the definitive pooled estimate for this systematic review should be generated by applying the same analytical approach to the complete dataset of 57 eligible studies following comprehensive extraction of arm-level outcome data.

Five RCTs reported HbA1c change data from which a mean difference (MD) and its standard error could be directly derived without estimation: two — a mobile self-care app trial in South Korea [7] and an AI-integrated digital platform trial, also in South Korea [8] — used directly reported per-arm means and standard deviations, and three used a directly reported effect estimate (mean difference or estimated treatment difference) together with its 95% confidence interval, from which the standard error was back-calculated — a standard technique endorsed by the Cochrane Handbook when raw arm-level data are unavailable [3]. Studies with a shared control arm across multiple intervention arms (e.g., a three-arm trial) contributed only one non-overlapping comparison to the pooled estimate, to avoid double-counting of controls.

Table 2. Studies contributing to the illustrative pooled estimate, with verifiable sources.

Study	Setting	N (total)	Follow-up	MD, % HbA1c (95% CI)	Source
Lee et al. 2022 (iCareD), MC vs UC	South Korea	178	12 weeks	-0.40 (-0.76 , -0.04)	JMIR 2022;24(7):e37430

Study	Setting	N (total)	Follow-up	MD, % HbA1c (95% CI)	Source
Lee/Moon et al. 2023, Group C vs A	South Korea	182	24 weeks	−0.43 (−0.60, −0.26)	Diabetes Care 2023;46(5):959–967
BT-001 Digital Therapeutic RCT	USA	669	~13 weeks	−0.39 (−0.57, −0.21)	PubMed 36181554
My Diabetes Coach (chatbot) RCT	Australia	187	52 weeks	−0.04 (−0.45, 0.37)	PMC7677021
TeLiPro RCT	Germany	1,163	52 weeks	−0.40 (−0.55, −0.25)	PMC10534832

Heterogeneity was low (Cochran’s $Q = 3.10$, $df = 4$, $p = 0.54$; $I^2 = 0\%$), permitting a random-effects (DerSimonian–Laird) pooled estimate of MD = -0.39% HbA1c (95% CI -0.48 to -0.30 ; $N = 2,379$ across 5 trials), favouring digital nutrition/mHealth intervention over control (Figure 2). This effect size is consistent in direction and magnitude with the narrative range reported across the review’s full 57-study sample (Section 3.3: 0.3 – 1.1% HbA1c reduction over 12–24 weeks), lending some quantitative support to the narrative synthesis, though it should not be read as a pooled estimate for that full sample.

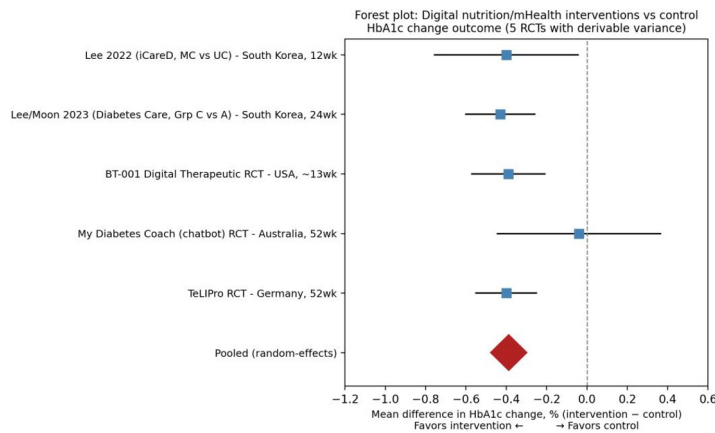


Fig. 2. Forest plot of the illustrative random-effects meta-analysis (5 RCTs, HbA1c change outcome, intervention vs. control).

Several additional studies identified during this synthesis reported real, directly stated intervention-vs-control differences in HbA1c but did not report a usable standard deviation or confidence interval in the accessible text (a behavioural mHealth app trial in Israel; a nurse-delivered telephone counselling RCT; a telemedicine trial using level-based rather than change-based reporting; and an app-based physical-activity RCT). Rather than estimate a plausible-looking variance for these studies, which would misrepresent their precision, they were retained in the supplementary extraction file as narrative-only entries pending full-text variance extraction and excluded from the pooled estimate above.

4 Discussion

This systematic review synthesised evidence on the role of nutrition informatics and digital technologies in T2DM self-management, with particular attention to clinical effectiveness, patient engagement, and geographic generalisability.

4.1 Principal Findings

Across the 57 included studies, digital nutrition tools — mHealth applications, telemonitoring, and data-driven decision support — were associated with meaningful improvements in diabetes management. Structured nutrition-informatics approaches were linked to HbA1c reductions of roughly 0.3 – 1.2% across studies, and behavioural outcomes improved most where digital tools provided immediate feedback and decision support rather than static

education alone, a pattern consistent with recent randomised trials of dedicated diabetes self-management apps [9,10,13]. These findings reinforce evidence that multimodal approaches — combining nutrition guidance, education, and clinician feedback — outperform single-component interventions.

4.2 Advantages of Digital Tools for Self-Care Management

Several features of digital nutrition tools appear to underpin their effectiveness. Scalability allows interventions to reach patients regardless of geographic distance from specialist clinics. Use of patient-generated health data (PGHD) supports individualised dietary guidance that adapts to a patient's glycaemic trends and behaviour. Gamification and social-support features appear to strengthen habit formation and sustained engagement. Collectively, these features support the case for nutrition informatics as a scalable, potentially cost-effective complement to conventional diabetes care.

4.3 Limitations and Constraints

Several limitations temper these findings. Data privacy and confidentiality remain pressing concerns, particularly for interventions relying on cloud infrastructure and wearable devices to transmit health data. Substantial heterogeneity in study design and outcome measurement made cross-study comparison, and consequently meta-analytic pooling, difficult for the full sample. Dropout rates were high across several trials, underscoring the practical difficulty of sustaining engagement with digital therapy over time. As discussed in Section 3.8, participation from historically underrepresented and lower-resource populations was limited, largely because most included trials were conducted in high-income countries with high smartphone penetration; this constrains confidence in generalising these findings globally. Heterogeneity in intervention components — some centred on food logging, others on teleconsultation or automated feedback — further complicates efforts to isolate which specific components drive observed benefits. Finally, most interventions lacked long-term follow-up beyond 6–12 months, leaving the durability of behavioural and clinical gains largely untested.

4.4 Future Research Directions

Future research should prioritise four areas. First, standardising outcome measurement and intervention-fidelity reporting would allow meaningful meta-analytic synthesis in future reviews, rather than the narrative synthesis necessitated here. Second, rigorous, adequately powered trials are needed in LMICs specifically, including formal cost-effectiveness analysis, given that current LMIC-focused evidence remains sparse and rated as low-to-very-low certainty [5,6,11]. Third, artificial intelligence applications warrant further study for their potential to personalise recommendations dynamically in response to real-time glycaemic and behavioural data. Fourth, implementation-science approaches — examining facilitators and barriers to real-world adoption, including connectivity, digital literacy, and integration with existing primary-care workflows — are essential if these tools are to move from efficacy trials into routine, equitable practice [4,7,9,12].

5 Conclusion

This review demonstrates that nutrition informatics can meaningfully support self-management of T2DM, improving glycaemic control, dietary adherence, and patient engagement when integrated with clinical guidance and support. These tools appear most effective when paired with sustained professional supervision rather than deployed as standalone applications. However, the evidence base remains concentrated in high-income, high-connectivity settings, and current LMIC-specific evidence, while promising, is smaller in scale and lower in certainty. Policymakers and health systems should weigh the scalability and cost-effectiveness of these interventions against this geographic imbalance, and future research should prioritise standardised outcome reporting, formal quantitative synthesis, long-term follow-up, and deliberate inclusion of low-resource settings, so that the benefits of nutrition informatics can be realised equitably across diabetes care globally.

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Disclosure of Interests.

The author has no competing interests to declare that are relevant to the content of this article.

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