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Digital health technologies and stakeholder incentives in type-2 diabetes prevention

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Abstract

Background: Type-2 diabetes (T2D) is largely preventable through sustained lifestyle change, yet healthcare systems face challenges in implementing and sustaining lifestyle interventions at scale. Digital health technologies (DHTs), offering personalized risk assessments, remote monitoring, and behavior change support, may support T2D prevention. However, the systemic role of DHTs within the T2D prevention ecosystem remains poorly understood. This study examines (RQ1) What stakeholder incentives are associated with prevention engagement among payers, providers, and individuals? (RQ2) What incentive patterns are associated with DHT adoption in T2D prevention? (RQ3) How is DHT adoption associated with value exchange among stakeholders in the T2D prevention ecosystem?

Methods: We conducted a systematic literature review to identify existing incentives in preventive care (RQ1). Business model data from leading DHT companies in T2D prevention (via PitchBook and Crunchbase) were analyzed to examine emerging incentive patterns (RQ2). We conducted expert interviews ($N = 26$) and synthesized findings using the e3-value framework to map stakeholder relationships (RQ3).

Results: Our findings show that financial and non-financial incentives for prevention are often temporally misaligned. Engagement in lifestyle-based prevention is linked to short-term rewards, health, and convenience benefits for individuals and long-term cost savings for payers. DHT adoption for T2D prevention is associated with three key patterns: enhancing personalization and convenience for individuals, supporting value-based payment models for payers, and improving workflow efficiency for providers.

Conclusions: DHTs may help align stakeholder incentives by promoting (1) sustained engagement in lifestyle prevention programs (i.e., continuous glucose monitoring with real-time dietary or activity feedback) and providing individuals with micro-rewards (i.e., for behavior change and improved clinical outcomes). These coordinated feedback loops could be embedded within (2) outcome-based reimbursements for payers and linked to (3) automated workflows to improve provider efficiency (i.e., risk stratification). Realizing this potential requires updated reimbursement models, integrated stakeholder coordination, and supportive policy frameworks.

Keywords

Diabetes prevention, digital health technologies, stakeholder incentives, implementation science, value-based care, healthcare ecosystems

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Introduction

Type-2 diabetes (T2D) presents a growing global health and economic challenge, with nearly USD 966 billion spent on diabetes care in 2021.[1] T2D is largely preventable through sustained changes in modifiable risk factors, such as diet and physical activity. A large body of work has demonstrated the effectiveness of lifestyle interventions in reducing T2D incidence and delaying disease progression and

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complications[2–5]; as well as cost-effectiveness for healthcare systems.[2–5] Despite this evidence, healthcare systems remain predominantly structured around acute care delivery. Current reimbursement models primarily incentivize treatment of diagnosed T2D—such as medication management, hospitalizations, and complication-related care—rather than lifestyle-based prevention, that is, proactive efforts to reduce the onset of disease through sustained lifestyle modification (i.e., low-glycemic diet, physical activity, and behavioral counseling) among individuals at-risk of T2D.[4,5] As a result, preventive lifestyle programs often face limited funding and long-term sustainability within healthcare systems.[6,7]

This disconnection between empirical evidence supporting lifestyle programs for T2D prevention and their limited implementation and sustainability in healthcare systems, in part, reflects a fundamental misalignment in stakeholder incentives. Here, we define stakeholder incentives as any factor (i.e., financial, non-financial) designed to influence the decision-making or behavior of individuals, providers, or payers towards engagement in preventive care.[8] In many healthcare systems, incentives for prevention vary widely among stakeholders and may conflict in practice. Providers often operate under reimbursement models that reward service volume, particularly acute and procedural care, rather than preventive engagement.[9,10] Meanwhile, individuals are expected to sustain lifestyle changes with minimal ongoing support after an intervention ends, which may limit their motivation to sustain behavior change. Payers, including insurers and government funders, interested in prevention, need to finance long-term costs but face difficulty attributing savings directly to specific interventions or actors.[11,12] Specifically, fee-for-service reimbursement models reward the quantity of acute interventions, such as hospitalizations, emergency visits, or medication adjustments, rather than continuous preventive care, including ongoing lifestyle counselling, regular physical activity promotion, or dietary support programs.[9,10,13] This reactive care bias could be further reinforced by payer's cost-containment pressures and the absence of effective policies to align incentives across multiple stakeholders, including patients, providers, payers, and regulators.[14,15] This fragmented operational and financial landscape makes T2D prevention challenging to fund, coordinate, or scale[16–18]. The result is systemic underinvestment in precaution, even when prevention is clinically effective and economically justified.[19]

Digital health technologies (DHTs), defined by the U.S. Food and Drug Administration (FDA) as "computing platforms, connectivity, software, and sensors used for healthcare and related purposes,"[20] have gained increasing attention for continuous lifestyle monitoring, risk assessments, and behavioral lifestyle support.[21] In T2D prevention contexts, DHTs often integrate remote monitoring and behavioral interventions, delivered through smartphones, or wearables (i.e., continuous glucose monitors (CGMs) or smartwatches) to support glycemic control—frequently leveraging advanced data analytics.[22] Research has examined factors influencing the adoption of DHTs by patients and healthcare providers, with studies identifying barriers, including technological interoperability and fragmented systems, as major impediments to widespread implementation.[23,24]

While adoption barriers at the individual and provider level have been documented,[13–15] stakeholder incentives across the broader healthcare ecosystem,[25] comprising individuals (i.e., patients or individuals at-risk of T2D), providers, and payers, remains unclear.[26,27] Building on recent studies that have begun to conceptualize T2D prevention from a system-level perspective[28–30] and describe ecosystems in T2D management, this study aims to map stakeholder incentives for prevention and identify incentive patterns associated with DHT use**.** Specifically, we examine the following three research questions: (RQ1): How are stakeholder incentives associated with engagement in T2D prevention among patients, providers, and payers? (RQ2): Which incentive patterns are associated with the adoption of DHTs in T2D prevention? (RQ3): How is DHT adoption associated with value flows among stakeholders in the T2D prevention ecosystem?

Theoretical background

Prevention as an ecosystem

Noncommunicable, chronic disease prevention often relies on a coordinated network of interdependent stakeholders, including individuals, healthcare providers, payers, and regulatory bodies. These actors collectively influence key underlying processes, including risk screening, the delivery of lifestyle programs, and their potential reimbursement.[31–33] Ecosystem theory conceptualizes this network not as a linear sequence of care delivery, but as a dynamic system in which value is co-created through shared infrastructure and ongoing value exchange among stakeholders.[34] To operationalize T2D prevention from an ecosystem perspective, we adopted the e3-value ontology, a modeling framework that defines an ecosystem through three core components: actors, value exchanges, and value interfaces.[35] Actors represent distinct organizational or individual stakeholders.[36,37] Value exchanges involve the transfer of goods, services, or information between two or more parties. Value interfaces define how exchanges are governed, that is, defining the transactional conditions under which exchanges occur. Applied to T2D prevention, the e3-value ontology allows us to describe associations between key stakeholders from a systemic (vs. single stakeholder) perspective,[25] with potential to identify stakeholder relationships and gaps in prevention pathways.

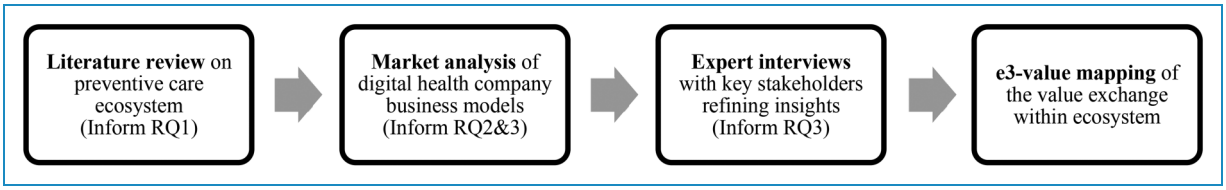

Figure 1. A mixed-methods approach for investigating associations between stakeholder incentives and DHTs in T2D prevention.

Methods

Research design

We adopted a mixed-methods design structured around the three key research questions. We integrated (1) a systematic literature review to identify existing incentives across payers, providers, and individuals (RQ1), (2) a market analysis of leading DHT companies to identify emerging incentive patterns linked to DHTs (RQ2), and (3) expert interviews to refine and validate incentive structures and explore stakeholder value exchanges (RQ3). The e3-value methodology[35,36] served as the underlying modeling framework. Drawing on prior applications in digital health and T2D management,[28,29] we used e3-value to map stakeholder incentives and highlight new patterns associated with the use of DHTs. Figure 1 illustrates our step-by-step application of the e3-value method, and Table 1 outlines each phase of the method, triangulating insights through a systematic literature review, market analysis, and expert interviews.[28,29]

Data collection

Systematic literature review. To examine how stakeholder incentives are associated with engagement in prevention among individuals, providers, and payers? (RQ1) We conducted a systematic literature review following the PRISMA 2020 guidelines, see Figure A1.[38] The review targeted peer-reviewed studies published between 2010 and 2023, a period previously marked by the onset of DHT adoption in chronic disease management and prevention.[39,40] We searched five academic databases, ScienceDirect, EBSCOhost, Web of Science, IEEE Xplore, and the ACM Digital Library. We used the following search terms: search terms "business model" or "health ecosystem with keyword-based constructs representing populations, interventions, and incentive mechanisms related to preventive care, chronic disease, and digital health, including "preventive care," "non-communicable disease," "chronic disease," "digital health," and "electronic health." Boolean operators and field restrictions were adapted to each database. The search strategy is detailed in Table A1. We performed a backward search to screen for additional relevant references cited in the identified articles.[39] Three researchers (Wasu Mekniran, Victoire Stalder, Wilma Diethelm) independently screened all titles and abstracts, reconciling discrepancies through discussion to ensure conceptual consistency. Given the qualitative focus of this review, thematic saturation was considered achieved when successive interviews no longer yielded new incentive categories or mechanisms, rather than based on statistical agreement metrics.

Studies were included if they (1) focused on stakeholder incentives in the abstract, (2) mentioned preventive care or DHTs within chronic disease management in the abstract, and (3) were peer-reviewed and published in English between 2010 and 2023. From each included study, we extracted publication characteristics, study design, stakeholder group, incentive type (financial or non-financial), and the reported mechanism linking incentives to prevention engagement. Extracted data were synthesized using thematic aggregation to derive recurring incentive categories. The literature screening and reviewing process was conducted using Covidence,[41] a web-based collaboration platform that streamlines the production of systematic literature reviews.

Table 1. Application of the e3-value mixed-methods approach.

Method	Objectives
1. Literature review	To examine overall stakeholder incentives, including care providers, payers, and individuals, to establish a baseline understanding of the incentives driving engagement in prevention (RQ1).
2. Market analysis	To identify new incentive models and value propositions of DHTs companies in T2D prevention, across funding stages and geographical regions (RQ2 and RQ3).
3. Expert interviews	To validate and expand findings from the literature review and market analysis, focusing on stakeholder roles and value exchange (RQ3).

Market analysis

To examine the incentives associated with DHT adoption in T2D prevention (RQ2), we conducted a market analysis of DHT companies active in T2D prevention. This approach is

Table 2. Search filter and search terms for the market analysis.

Search category	Search terms
Industry	Healthcare Services Other Healthcare Services Clinics/Outpatient Services Healthcare Technology Systems
Vertical	Digital Health HealthTech
Keyword	Diabetes Metabolic Health

critical as the business models of these firms inherently reflect the specific value propositions and exchange mechanisms designed to incentivize engagement from individuals, providers, and payers.[30,42] Company-level data were retrieved and screened from PitchBook, a global private capital database,[43] on April 16, 2024, and the funding status of screened companies was updated on October 10, 2025. The initial search returned 602 companies, filtered using the following industry categories: "healthcare services," "outpatient care," and "digital health," alongside the following keywords: including "diabetes" and "metabolic health." Detailed search categories and search terms are presented in Table 2.

To capture companies with distinguishable market traction and scalability, we selected the top 100 companies ranked by total funding in PitchBook. This threshold was chosen to prioritize firms with publicly traceable operations and validated investment activity, thereby enhancing the comparability of business-model data while acknowledging potential survivorship bias. Three entries were excluded due to missing data, leaving 97 companies for full screening. Inclusion criteria comprised: explicit engagement in T2D prevention, provision of a digital health component within the core offering, and sufficient documentation in English to allow systematic business model assessment. Exclusion criteria included seed-stage companies. A total of 32 companies met all inclusion requirements. The selection and screening workflow is depicted in Figure A2.

A structured content analysis was conducted using the value proposition dimension of Foss and Saebi's business model innovation framework, see Table A2 for the codebook.[44] Two researchers (Wasu Mekniran, Victoire Stalder) independently reviewed PitchBook profiles, Crunchbase entries,[45] and official websites to extract three elements: (1) core market segment (i.e., diagnostics, therapeutics), (2) target customer (i.e., employer, payer, diagnostic center), and (3) value object delivered (i.e., intervention, data, convenience). Discrepancies were resolved by a third researcher (Wilma Diethelm). These elements were synthesized to identify recurring incentive logics, which informed the subsequent ecosystem modeling using the e3-value approach.[37]

Expert interviews

To validate the stakeholder incentives identified through the systematic literature review and market analysis, we conducted 26 semi-structured interviews with experts directly involved in the delivery, financing, or governance of T2D prevention in their respective local healthcare setups. Participants represented diverse local healthcare systems across 13 countries, primarily from Europe ($n = 16$; Switzerland $n = 11$, Hungary $n = 1$, the Netherlands $n = 1$, France $n = 1$, Poland $n = 1$, and the United Kingdom $n = 1$), followed by Asia-Pacific ($n = 5$; Singapore $n = 1$, Indonesia $n = 1$, Thailand $n = 1$, the Philippines $n = 1$, and Pakistan $n = 1$), Australia ($n = 1$), and the Middle East/Africa ($n = 1$; Egypt $n = 1$). Participants represent seven stakeholder groups, including payers ($n = 10$), healthcare providers ($n = 7$), investors or consultants ($n = 3$), policy leaders ($n = 2$), manufacturers ($n = 2$), academic researchers ($n = 1$), and the support community ($n = 1$); as detailed in Table A3. Interviews were conducted via video call between January and June 2024 (mean duration, 32 min), guided by a standardized protocol that included interview questions aligned with RQ1 and RQ2, as shown in Table 3. The interview protocol consisted of nine questions grouped into three analytical domains: (1) preventive care incentives, (2) ecosystem dynamics, and (3) business model innovation.

Interview transcripts were coded in ATLAS.ti[46] tool using a deductive coding framework, drawing on the Business Model Innovation (BMI) concept. BMI examines how business models are transformed in response to internal and external drivers[44] and business model patterns.[47] Codes covered antecedents, moderators, outcomes, and business model elements, as defined in the coding framework in Table 3. Two researchers (Wasu Mekniran, Wilma Diethelm) coded the interview transcripts independently, with discrepancies resolved by a third researcher (Victoire Stalder). Thematic saturation was reached after 26 interviews, see Table A3. This study was granted a formal Letter of Exemption by the Ethics Committee of the University of St Gallen (September 30, 2025), under institutional guidelines. All interview participants provided verbal informed consent prior to participation. No compensation was offered, and all transcripts were anonymized and securely stored.

The systematic literature review and market analysis relied exclusively on publicly available data and therefore did not require ethics approval. From the included studies, we identified 39 unique incentives driving engagement in prevention across stakeholders (17 financial and 22 non-financial). For instance, financial incentives included performance-based payments for providers and premium reductions for individuals, while non-financial incentives

Table 3. Interview themes, questions, codes, and definitions.

Theme	Interview question	Code	Definition
Preventive care incentives	What is the relevance of disease prevention for your entity?	Antecedents: external	System-level changes in competition, regulation, or stakeholder dynamics
	What strategies does your entity undertake to prevent diseases?	Antecedents: internal	Organizational capabilities, strategic orientation, or internal change drivers
Ecosystem dynamics	What role does your entity have in this emerging ecosystem?	Moderators: firm-level	Organizational values, roles, norms, or cultural alignment
	What opportunities do you see for your entity in future healthcare ecosystems?	Moderators: firm-level	Ecosystem benefits perceived by the firm
	What challenges do you see for your entity in preventive ecosystems?	Moderators: firm-level	Structural, cultural, or operational constraints at the firm level
	What conditions must be met to realize a functional preventive ecosystem?	Moderators: macro-level	Regulatory, legal, or policy conditions for ecosystem coordination
Business model innovation	How does your entity currently collaborate with others?	BMI: how	Delivery mechanisms, partnership configurations, or channels
	What are the incentives behind these collaborations?	BMI: value	Economic rationale or strategic logic for partnership/collaboration
	How and with whom do you imagine working in the future?	BMI: how	Anticipated delivery models or business ecosystem evolution

encompassed enhanced professional reputation and access to personalized health coaching.

Results

RQ1: Incentives associated with engagement in prevention among payers, providers, and individuals

From these included studies, we identified a variety of different incentives associated with prevention engagement across individuals, payers, and providers in the literature (39 unique incentives; 17 financial and 22 non-financial in total). Examples of financial incentives included performance-based payments for providers and premium reductions for individuals, while non-financial incentives included enhanced health outcomes, recognition, and access to personalized lifestyle coaching. Drawing on prior value exchange evaluation studies,[29,35] we further categorized incentives by temporal orientation: short-term incentives were defined as benefits realized within six months, and long-term incentives as benefits accruing beyond six months. Among individuals, the majority of identified incentives (8 of 9) were short-term, emphasizing immediate, tangible benefits such as short-term health improvements, financial rewards, convenience, or personalized health feedback. In contrast, the majority (4 of 5) payer incentives and a large number (9 of 16) of provider incentives were long-term, focusing on population health outcomes, operational efficiency, and cost containment.

This temporal divergence reflects a persistent misalignment of incentive horizons and perceived value: individuals prioritize immediate personal gains, whereas institutions emphasize delayed systemic benefits. For example, individuals are likely to be more responsive to short-term health benefits tied to prevention programs, such as weight loss or improved glucose metrics, while providers and payers value long-term improvements in population health and cost savings, that is, related to T2D incidence. Table 4 summarizes the typology and key points of divergence.

Individuals. Our literature review suggests that both financial and non-financial incentives are important factors to motivate individuals to engage with lifestyle prevention programs. Financial incentives, specifically, reduced insurance premiums, have been shown to increase short-term and sustained participation in preventive lifestyle programs by lowering direct monthly costs in healthcare systems.[48] Short-term incentives such as vouchers, cashback, or small monetary rewards have also been shown to encourage short-term behavior change and initial engagement with lifestyle interventions.[49] Additionally, the option to pay out of pocket allows individuals to access a broader range

Table 4. Typology of incentives in prevention, categorized by stakeholder, financial/non-financial type, and temporal horizon.

Stakeholder	Type of payoff	Payoff	Expected outcome	Time horizon	Point of misalignment	References
Individuals	Financial	Reduced premiums for participation	Increased participation in prevention program	Short-term + Long-term	Short-term incentives often not prioritized	[49]
Individuals	Financial	Additional rewards for behavioral change (i.e., vouchers, cashback)	Increased participation in prevention program	Short-term	Payers do not always maintain consistent short-term rewards	[49]
Individuals	Financial	Out-of-pocket option for preventive services	Freedom to choose a variety of prevention programs	Short-term	Not aligned with systems prioritizing long-term population outcomes	[50,51]
Individuals	Non-financial	Health guide and education for risk and lifestyle management	Improved health literacy, care efficiency, and motivation for behavior change	Long-term	Often undervalued due to a long clinical feedback	[29,50,52–55,62]
Individuals	Non-financial	Access to early risk detection and preventive intervention	Early detection of chronic disease risk	Short-term	Providers prioritize clinical needs over accessibility	[53,56–58]
Individuals	Non-financial	Convenience (i.e., integration into daily routines via apps	Usage satisfaction with digital tools and prevention programs	Short-term	Systemic programs rarely optimize for user experience	[52,60]
Individuals	Non-financial	Personalization of intervention (i.e., risk scores, nudges, content)	Better health outcomes, sustained motivation for prevention	Short-term + Long-term	Institutional offerings are often too generic	[52,59]
Individuals	Non-financial	Recognition from care teams or peer networks	Motivation, retention in prevention programs	Short-term	Rarely included in formal incentive schemes	[49]
Individuals	Non-financial	Privacy protections for health data	Trust from users in digital solutions	Short-term	Institutions rely on data, while individuals are hesitant to share	[60]
Payers	Financial	Cost containment for chronic disease management	Lower long-term healthcare costs due to averted complications	Long-term	Savings from preventive intervention are not immediately visible	[49,51,52,61]
Payers	Financial	Increased revenue from healthy participants	Improved provider performance in prevention metrics	Long-term	Increased costs up front are not always justified	[60]

(continued)

Table 4. Continued.

Stakeholder	Type of payoff	Payoff	Expected outcome	Time horizon	Point of misalignment	References
Payers	Non-financial	Risk reduction (i.e., reduced complication incidence)	Reduce the overall risk profile for chronic disease burden	Long-term	Hard to quantify and link to ROI	[57]
Payers	Non-financial	Retention of members/ policyholders	Improved customer lifetime value	Long-term	Impact difficult to attribute to a single program	[52]
Payers	Non-financial	Productivity with analytics tools for population health management	Improved operational process for risk stratification	Short-term + Long-term	High implementation costs or data challenges	[61]
Providers	Financial	Pay-for-performance/ Value-based	Enhanced focus on preventive care	Long-term	Performance-based metrics not aligned with patient motivations	[51]
Providers	Financial	Bundled payments model	Fix costs to provide care	Long-term	Upfront investment needed to manage bundles	[49,56]
Providers	Financial	Commissions	Transition from sick to health care	Short-term	Rarely linked to prevention outcomes	[52]
Providers	Financial	Tier-based payment model	Direct care access	Short-term	Unclear coverage and accountability	[33]
Providers	Financial	Freemium model	User awareness, lock-in effect	Short-term	Risk of underfunding care	[33]
Providers	Financial	Platform model	Data traffic, lock-in effect	Long-term	Not always tied to quality of care	[33,51,63]
Providers	Financial	Subscription model, licensing fees for prevention platforms	Lock-in effect for digital solutions	Short-term + Long-term	Motivation misaligned with patient outcomes	[49,62]
Providers	Financial	Fee for Service, Pay per use model for digital prevention services/ consultations	Lower barrier for user adoption of preventive care	Short-term	Does not reward long-term outcomes	[33,49,51,54,61,62]
Providers	Financial	Investment in R&D for preventive technology	Sustainable development of innovative preventive care	Long-term	Delayed returns, high cost	[51,62,64]
Providers	Non-financial	Patient outcomes in prevention (i.e., blood glucose control, weight management)	Better healthcare quality in preventive care delivery	Long-term	Not tied to direct revenue	[51,52,61]

(continued)

Table 4. Continued.

Stakeholder	Type of payoff	Payoff	Expected outcome	Time horizon	Point of misalignment	References
Providers	Non-financial	Preventive care training	Increased capacity for delivering effective prevention	Long-term	Opportunity cost of training time	[64]
Providers	Non-financial	Health data, measurement from digital tools	Enhanced personal data, lock-in effect	Short-term + Long-term	Tension with individual privacy	[50,51,61]
Providers	Non-financial	Device, medical supplies (i.e., connected sensors)	Ability to measure biomarkers, monitor risk	Short-term	Cost is not always reimbursed	[53,54]
Providers	Non-financial	Regulatory and policy support for preventive care	Faster to market for new preventive interventions	Long-term	Dependence on government action	[29,33,59,60]
Providers	Non-financial	User engagement with prevention programs	Usage moderation for optimized program effectiveness	Short-term	Not financially rewarded	[54,55]
Providers	Non-financial	Reduced workload via automation	Reduced stress for healthcare staffs	Short-term	Efficiency gains not linked to income	[50]
Overall	Financial	Shared savings programs based on prevention outcomes	Distribution of savings across the ecosystem	Long-term	Takes time to realize savings	[56]
Overall	Financial	Awareness of prevention benefits among the public	Higher participation in prevention programs	Short-term	Hard to sustain awareness	[52,60,62]
Overall	Financial	Customer base expansion for preventive solutions	Market access, scaling effect for preventive tools and programs	Long-term	Scaling takes time	[50,54,56,57,60,63–65]
Overall	Non-financial	Technology and data sharing for prevention insights	Improved collaborative preventive care delivery	Long-term	Misalignment on data governance	[29,33,54–56,58,59,62,66]
Overall	Non-financial	Collaboration among ecosystem stakeholders	Open innovation in preventive interventions	Short-term + Long-term	Lack of trust across stakeholders	[29,33,51,52,55,62,64,65]
Overall	Non-financial	Evidence from research on prevention effectiveness	Transparency and trustworthiness of prevention approaches	Long-term	Often not integrated into decision making	[53,54,66]

(continued)

Table 4. Continued.

Stakeholder	Type of payoff	Payoff	Expected outcome	Time horizon	Point of misalignment	References
Overall	Non-financial	Process digitization in healthcare workflows for prevention	Efficiency, accessible care for prevention	Short-term	Digital maturity varies	[51,57,58]
Overall	Non-financial	Talent acquisition and prevention expertise	Attractive to workers in the preventive care	Short-term + Long-term	Not a core key performance indicator	[63]
Overall	Non-financial	Security of preventive intervention	Trust from users and overall confidence in preventive care delivery	Long-term	Often not visible to users	[62]

of prevention services, such as specialized dietary coaching or personalized exercise programs, thereby promoting consumer autonomy.[50,51]

Our review suggests that non-financial incentives are similarly important for individuals. Access to lifestyle guidance, delivered through digital coaching, personalized reports, or community seminars, has been shown to improve health literacy and motivation for lifestyle behavior change.[50,52–55] Further, personalization of interventions through tailored risk scores, nudges, or content delivery has also been found to foster sustained motivation and the likelihood of behavior change.[53,56–59] Convenience, such as integrating coaching, reminders, or glucose feedback into existing mobile routines (i.e., via smartwatch notifications or calendar-linked nudges), is also a significant driver of engagement with preventive interventions.[52,60] Additionally, support and recognition from care teams and peer networks can improve user adherence and satisfaction with prevention programs.[49]

Payers. Payers, including both public and private insurers, have financial incentives to invest in prevention, as shared savings programs may allow payers to fund preventive interventions and later benefit from avoided costs associated with acute disease management.[49,51,52,61] Such programs often aim to tie medical cost savings to the performance metrics of prevention programs, thereby aligning financial incentives with providers. In certain healthcare contexts, such as revenue opportunities for payers, bundling preventive services with supplementary insurance offerings, such as wellness, dental, or vision packages, with the potential to enhance customer acquisition and retention.[60]

Non-financial incentives include reduced portfolio risk across population segments. By lowering the prevalence of chronic conditions, payers may experience lower overall claims, long-term savings, lower claim volatility, and improved actuarial predictability.[57] Customer retention is another strategic benefit: policyholders are more likely to remain loyal to insurers that offer proactive, value-added services.[52] With the help of advanced analytics and segmentation tools, payers may also support more efficient customer targeting, resource allocation, and preventive service personalization,[61] reinforcing long-term customer value and operational sustainability.

Providers. Healthcare providers, including general practitioners, specialists, and integrated care teams, play a crucial role in enabling preventive care. Pay-for-performance models often reward measurable outcomes, such as weight loss, medication adherence, or clinical improvements (i.e., glycemic control), aligning revenue with health improvements.[51] By participating in bundled or subscription-based pay-for-performance models, providers can be incentivized to perform early risk assessments, monitor lifestyle behaviors, and coordinate care effectively to ensure patients access to appropriate lifestyle and clinical decision support.[49,56,62] While fee-for-service structures are still common, especially in systems without mature prevention reimbursement, pay-for-performance models can enable providers to monetize preventive interventions.[33,48] For example, digital business models, such as subscription-based or freemium apps, may incentivize healthcare providers to offer preventive care and improve health outcomes[33,51,63]; thereby aligning immediate clinical action with long-term health outcomes.

Non-financial incentives encourage healthcare providers to engage in preventive care by supporting both professional effectiveness and patient impact. Providers gain satisfaction from improving patient outcomes and strengthening relationships, while early interventions reduce administrative burden and improve clinical efficiency.[8,61] Access to real-time biometric and behavioral data further enhances decision-making, enabling providers to triage visits effectively and allocate time and resources where they are most

needed. Training, continuing education, and participation in quality improvement initiatives help providers adopt evidence-based practices and advance their professional development.[64] Finally, involvement in collaborative research programs, recognition from peers, leadership opportunities within care teams, and contributions to organizational population health goals reinforce providers' sense of expertise and long-term impact, motivating sustained engagement in preventive care.

Incentive misalignment

Despite growing interest in prevention, misalignments persist across stakeholders along both financial and temporal dimensions. Our results suggest that individuals are primarily motivated to engage with prevention through short-term, tangible benefits such as financial rewards for sustaining healthy behaviors (i.e., vouchers or app-based cashback), ease of use of lifestyle interventions and low burden (i.e., frictionless app onboarding), and access to personalized feedback (i.e., real-time glucose trends, tailored lifestyle advice via app notifications and or/ digital coaching), and short-term or immediate tangible health improvements.[49,52,59] However, these short-term individual-level incentives are often undervalued in system-level designs, which prioritize long-term population-level outcomes, such as cost avoidance from avoided hospitalizations or risk reduction for population-level indicators like T2D incidence.[51,60,61]

Misalignments also occur in data governance. For example, providers may use risk assessment scores derived from EHR data to stratify patients into personalized prevention pathways, while insurers may use engagement data from prevention programs or claims analytics to provide financial rewards.[48] Yet individuals are often reluctant to share their personal health data without strong assurances of privacy and transparency.[60] Moreover, while payers and providers may aim to optimize for efficiency and scalability, individuals prioritize trust and convenience. Relatedly, there remains a disconnect between individual and population-level incentives. Short-term individual incentives (such as motivating individuals to engage in prevention with cashback rewards in exchange for daily steps) remain disconnected from long-term systemic returns (i.e., evidence of a reduction in population-level chronic disease incidence as a function of step count), potentially undermining the systemic sustainability of lifestyle prevention programs.

RQ2: Incentive patterns and adoption of DHTs in T2D prevention

The included sample of selected top-funded companies reflects a diverse set of DHT providers founded between 2008 and 2022, with the most active founding years between 2010 and 2019. A summary of the founding years is presented in Table 5. Funding status search and classifications were distributed across early-stage venture ($n = 15$), private equity ($n = 7$), late-stage venture ($n = 4$), post-IPO ($n = 3$), M&A ($n = 1$), seed ($n = 1$), and closed ($n = 1$); as of October 2025. Headquarter locations show that most included companies were based in the United States ($n = 22$), followed by India ($n = 3$), with the remainder distributed across seven other countries, including Australia ($n = 1$), Finland ($n = 1$), France ($n = 1$), Germany ($n = 1$), New Zealand ($n = 1$), Switzerland ($n = 1$), and United Kingdom ($n = 1$).

Based on the market analysis, we identified three dominant incentive patterns associated with the use of DHTs in the T2D prevention ecosystem: (1) Among individuals, DHTs are associated with enhance individual access to personalized health insights, (i.e., biometric T2D risk screening and recommendations), and motivation to engage in lifestyle interventions (i.e., digital coaching, wearable feedback). Among payers (2), DHTs are associated with support value-based payment for payers, via outcome-linked reimbursement and engagement-based pricing. Among payers (3), DHTs are associated with provider organizational workflow efficiency, that is, through remote continuous monitoring, care team coordination, and patient stratification and triage.

Individuals: Sustained engagement in digital prevention programs through personalized health insights and continuous monitoring in daily life. Of the 32 companies analyzed, 23 companies target individuals with value propositions centered on personalized guidance for T2D prevention and management, delivered through digital coaching, remote monitoring, and mobile app platforms. A majority of these services fall into the care guiding ($n = 8$), intervention ($n = 6$), or monitoring ($n = 6$) market segments. Companies like Noom (2008), Omada Health (2011), and Oviva (2013) deliver coaching programs designed to sustain healthy behavior change, while platforms like Supersapiens (2019) and Glooko (2010) offer continuous glucose monitoring insights with risk assessments. January AI (2017) and Lark Health (2011) embed behavioral nudges and AI-driven coaching into consumer apps, aiming to sustain engagement over time.

These DHT-based solutions aim to align short-term individual motivations (convenience, feedback, community) with long-term outcomes (reducing T2D incidence, improving app use adherence). The resulting generation of continuous, individual-level health and engagement data may provide a new basis for realigning incentives across the T2D prevention ecosystem. For instance, providers may leverage individual-level health and DHT engagement data to gain actionable insights for personalized lifestyle recommendations and decision support, while payers may

Table 5. Companies included in the market analysis: country, funding status, market segment, value object, and target customer.

Company	Year	Country	Funding status	Market segment	Value object	To whom
9amHealth	2021	US	Early	Management	Support/guideline	Individual
BeatO	2015	India	Early	Monitoring	Support/guideline	Individual
Better Therapeutics	2015	US	Post-IPO	Therapeutics	Care/intervention	Individual
BOYDSense	2019	France	Private Equity	Diagnostics	Medical supplies/ devices	Medical device manufacturer
Breathe Well-being	2015	India	Early	Monitoring	Data	Individual
Calibrate	2019	US	Early	Therapeutics	Care/intervention	Individual
Caristo Diagnostics	2017	UK	Early	Diagnostics	Data	Diagnostic center
Companion Medical	2013	US	Closed	Medical device manufacturer	Medical supplies/ devices	Distributor
DarioHealth	2011	US	Post-IPO	Therapeutics	Medical supplies/ devices	Individual
DiaMonTech AG	2015	Germany	Private Equity	Medical device manufacturer	Medical supplies/ devices	Research Entity
Digbi Health	2018	US	Early	Diagnostics	Data	Employer
Digital Diagnostics	2010	US	Early	Diagnostics	Efficiency/cost reduction	Specialist
Eyenuk	2010	US	Early	Diagnostics	Data	Diagnostic center
Fitterfly	2016	India	Early	Wellness	Care/intervention	Individual
Fruit Street	2014	US	Early	Wellness	Convenience	Individual
FULLFILL	2019	US	Early	Therapeutics	Care/intervention	Health insurer
Glooko	2010	US	Late	Monitoring	Data	Individual
Human Longevity	2013	US	Private Equity	Analytics	Data	Individual
Ilumivu	2009	US	Early	Clinical decision support	Care/intervention	Individual
January AI	2017	US	Private Equity	Management	Support/guideline	Individual
Knownwell	2022	US	Early	Outpatient/Clinics	Care/intervention	Individual
Lark Health	2011	US	Late	Monitoring	Access/rights/license	Individual
Livongo (Teladoc)	2008	US	M&A	Monitoring		Individual

(continued)

Table 5. Continued.

Company	Year	Country	Funding status	Market segment	Value object	To whom
					Medical supplies/ devices	
Noom	2008	US	Late	Therapeutics	Support/guideline	Individual
Omada Health	2011	US	Post-IPO	Management	Support/guideline	Individual
Oviva	2013	Switzerland	Late	Management	Support/guideline	Individual
Supersapiens	2019	US	Private Equity	Monitoring	Data	Individual
Tesis Biosciences	2019	US	Private Equity	Analytics	Data	Diagnostic center
Toku Eyes	2018	New Zealand	Early	Diagnostics	Data	Diagnostic center
Veri	2020	Finland	Early	Management	Support/guideline	Individual
Vida Health	2014	US	Private Equity	Wellness	Access/rights/license	Individual
Vively	2020	Australia	Seed	Management	Support/guideline	Individual

leverage individual-level data for risk stratification, to measure evidence for cost containment, and to develop value-based contracts for prevention. Yet, while in theory promising, health and cost improvements linked to DHT use were rarely reported in our expert interviews, underscoring the lack of available longitudinal health (i.e., glycemic) and cost measures in combination.

Payers: Healthcare cost containment through value-based models. Only two companies explicitly target payers or employers, but this represents a growing strategic shift, as companies such as Lark Health (2011), Livongo (2008), Omada Health (2011), and Oviva (2013) are providing reimbursable T2D prevention programs backed by payers in their respective healthcare systems. In the case of FILLFILL (2019), for example, payment to payers is tied to reductions in glycated hemoglobin (HbA1c)—a clinical measure of long-term glycemic control and a key indicator of T2D progression.[73] In principle, such models may help align incentives across stakeholders: subsidized access to preventive programs may support uptake among individuals; outcome-linked reimbursement may promote performance incentives for providers; and payers may benefit from long-term cost containment, supported by T2D prevention programs. However, our analysis reveals that few companies have demonstrated evidence for sustained real-world cost savings at scale (i.e., BeatO, Lark Health, Noom, Omada Health). A persistent gap remains between the long-term (i.e., over 15–20 years) realization of prevention-related cost-saving and the typical short-term (i.e., 1–5 years) contracting cycles of many payers. Moreover, evidence around cost-effectiveness and clarity regarding reimbursement mechanisms for DHT-supported programs remains limited.

Providers: Workflow integration and diagnostic support. Approximately one-third of the companies in our sample focus on supporting clinicians and diagnostic providers in optimizing their workflows to enhance T2D screening, diagnosis, and related complications. Companies like Caristo Diagnostics (2018), Eyenuk (2010), and BOYDSense (2015) offer AI-enhanced screening and early detection of T2D and its complications, aiming to streamline clinical workflows through automated data capture and analysis presented in integrated provider and user-facing dashboards. For example, Digital Diagnostics (2010) incorporates clinical decision support into practice, potentially reducing missed diagnoses and enhancing efficiency. However, based on our interviews, providers remain cautious about widespread DHT adoption, citing integration costs, unclear liability pathways, and a lack of reimbursement as major deterrents to their integration into routine practice and scalable implementation.[60,67,68]

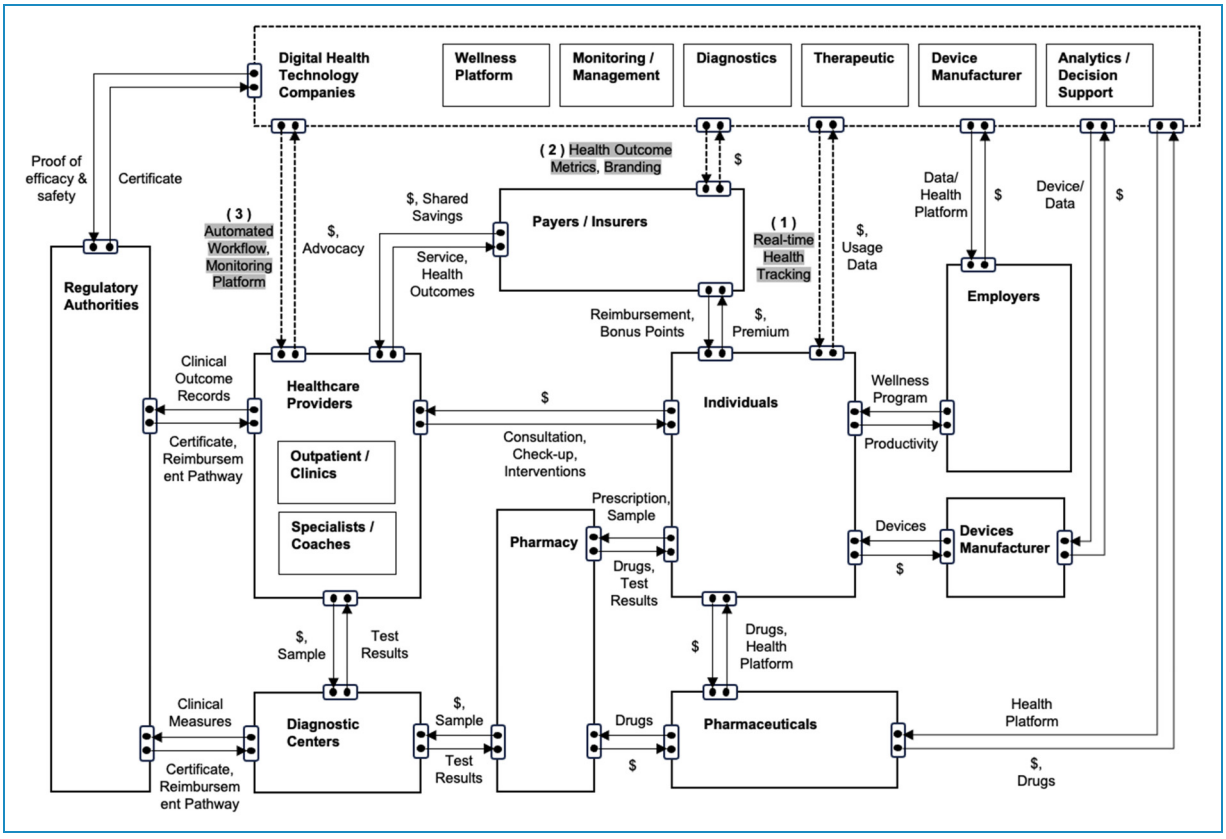

Figure 2. Diagram illustrating value exchange between key stakeholders in the digital diabetes prevention ecosystem, highlighting (3) potential DHT-enabled transformations.

While these DHT-based solutions offer automation benefits, their adoption depends heavily on alignment with clinical incentives and workflow compatibility. When successfully integrated, provider-focused DHTs may potentially enhance clinical efficiency, leading to significant organizational benefits. For instance, automated retinal screening for diabetic retinopathy, as offered by Eyenuk, can reduce the need for specialized ophthalmologist visits, potentially saving costs per screening in some settings by freeing up physician time and accelerating time-to diagnosis.

RQ3: Associations between DHT adoption and value flows among stakeholders in the T2D prevention ecosystems

Combining interviews and insights from the literature review, spanning 1005 coded excerpts derived from 14 h of expert interviews in Table A3 and Table A4, 32 DHT companies, and 21 peer-reviewed articles, we identified three interrelated mechanisms through which DHTs are associated with potentially changing value flows and stakeholder relationships in the T2D prevention ecosystem.

First, (A) DHTs may enable the emergence of new collaborative networks by expanding the roles of non-traditional providers, such as digital health coaches delivering personalized lifestyle interventions. Second, (B) digital platforms make it increasingly possible to automatically link payments to engagement or preventive outcomes through data-driven, conditional reimbursement mechanisms, potentially changing financial relationships in the T2D prevention ecosystem. Third, (C) accountability among individuals, providers, and payers may also shift as DHT-based models challenge existing regulatory and governance frameworks and redistribute responsibility. For example, individuals become more accountable for self-monitoring and lifestyle management through apps or wearable devices that track activity, diet, or glucose. Providers may face increased accountability via dashboards and analytics that show patient engagement and adherence, allowing performance monitoring at the individual or population level.

Furthermore, payers may be increasingly held accountable for supporting effective preventive programs through outcome- or engagement-linked reimbursements, such as paying only when users reach target risk thresholds or achieve measurable improvements. Figure 2 depicts how DHTs may serve as enabling infrastructure for a transition toward more integrated, data-driven T2D prevention. However, despite the potential structural change, the long-

term clinical and economic benefits of these transformations remain to be validated.

Emerging collaborative networks and the expanding role of non-traditional providers. DHTs are associated with shifts in how preventive care is organized, with non-traditional providers increasingly occupying roles that have historically been concentrated within clinical settings. Consumer-oriented digital health platforms, in particular, are observed to operate across both wellness and clinical domains. Hybrid platforms such as January AI (2017), Digbi Health (2018), and Caristo Diagnostics (2017) illustrate this pattern, positioning themselves at the intersection of self-management and clinical decision support and interacting with both providers and payers. Supersapiens (2019), for example, integrates real-time glucose tracking with performance analytics to serve both personal health optimization and clinical use cases, functioning as an intermediary between individuals and providers. These developments coincide with broader institutional adjustments across the healthcare landscape. Established actors appear to be redefining their roles in response to the growing presence of DHTs.

Medical associations, for instance, are positioning themselves as trust brokers by evaluating and endorsing digital tools. As one association founder explained, "We would almost be a trust layer … vet a product and say this is good based on research" (ID 1). Primary care physicians also describe expanded activities beyond traditional clinical encounters, including public education and digital outreach. One community-based physician noted, "My initiative is to educate the people through social media as my responsibility" (ID 2). Some academic researchers similarly report increased involvement in applied, community-based DHT prevention programs, such as co-developing strategic frameworks and health literacy materials with schools and public health institutions (ID 3). Insurers are likewise reported to be broadening their scope beyond claims administration. Through investments in DHT startups and partnerships with technology firms, insurers articulate aspirations to engage more directly in prevention and care coordination. As one insurer explained, "We want to play a role as a healthcare partner for our customers," while also noting the growing influence of technology companies that "are super active with their platforms and collect valuable prevention data" (ID 6). In parallel, wellness platforms and workplace coaching programs (ID 9) are cited as mechanisms through which insurers participate in more integrated, service-oriented prevention arrangements.

Potential realignment of financial ties via programmable incentive architectures. DHTs are associated with changes in how preventive care is financed by embedding near-real-time behavioral and physiological data into adaptive incentive systems. Unlike traditional reimbursement models that reward one-off, reactive treatments, emerging DHT-enabled models promote continuous engagement and outcomes-based payments. Platforms such as BeatO (2015), Glooko (2010), and Lark Health (2011) exemplify this transformation. These DHT-based example companies use biometric feedback loops—integrating glycemic control metrics, lifestyle patterns (such as physical activity), and medication adherence—combined with AI-driven behavioral nudges and real-time coaching to guide users toward healthier behaviors. This approach aims to replace static benefit structures with dynamic financial models where outcomes and payments are closely linked. FULLFILL (2019), for instance, ties its revenue to improvements in glycemic markers, while Veri (2020) and Supersapiens (2019) monetize real-time adherence, aiming to turn behavioral compliance into a billable asset.

Insurers are beginning to adopt similar models. For example, some insurers in Belgium and Switzerland currently offer digital programs that reward preventive behavior with micro-incentives, as one insurer described: "We promote and reward healthy behavior through our app" (ID 6). Others link provider payments to patient adherence: "We remunerate the doctor … if he makes sure that some people adhere to the standards" (ID 7). Additional strategies include loyalty-based engagement: "If you use this app, you collect points … discounts, vouchers" (ID 9), and ecosystem positioning "We now shift towards being a companion for all aspects of health" (ID 8). However, as one CIO noted, "Investments in prevention typically do not take place where the benefits accrue" (ID 9), highlighting a potential structural misalignment: payers funding preventive programs (i.e., such as short-term cashback programs) may not directly capture the long-term returns in investment, as individuals may switch private insurance providers in different healthcare contexts, such as in Swiss context.

New actors are also entering the T2D DHT prevention ecosystem e by experimenting with decentralized incentive architectures. For example, a pharmacist-led longevity platform uses blockchain to reward users with utility tokens for engaging in healthy behaviors, such as a low-glycemic diet and sharing their meals: "Upload your meals for today. You earn a few utility tokens" (Content Strategist, ID 23). Yet, two of our interviewees further suggested that technical innovation alone is not enough for sustainable T2D prevention. As one digital health entrepreneur emphasized, "For prevention to really make an impact, we need structural and legislative changes," warning that "poor data leads to inconclusive results" (ID 26). Others point to scalability barriers: "Only the bigger teams … with a lot of funding … can succeed in this ecosystem" (DHT Developer, ID 5), underscoring that the promise of data-driven incentive models depends not just on technological feasibility, but on institutional coordination and equitable access, the bigger teams … with a lot of funding … can succeed in this ecosystem" (DHT Developer, ID 5).

Potential to reshape accountability: Regulatory tensions in the digital health era. DHTs are evolving faster than the regulatory systems designed to oversee them.[8,68,69] By integrating behavioral and physiological data with AI-driven feedback loops, some DHT tools are increasingly challenging established frameworks for classifying medical devices, reimbursement pathways, and data governance legislation. While some platforms, such as Better Therapeutics (2015) and Noom (2008), have aligned themselves with behavioral CPT codes to gain reimbursement in the U.S., more complex hybrid models, like Companion Medical (2013) and BOYDSense (2019), often fall outside conventional regulatory categories. Their integration of sensing, behavior modification, and predictive analytics resists straightforward mapping onto existing billing and certification taxonomies.

These tensions play out across multiple regulatory layers, including platform access, coding and reimbursement, and data use restrictions. Developers often encounter commercial barriers before they ever reach clinical regulation: "Apple and Google Play store policies constrain smaller teams," one engineer explained, adding that "only bigger teams with funding succeed" (DHT Developer, ID 5). Insurers, too, face legal and structural constraints: "We are not allowed to use our customer data for marketing" (Insurer, ID 6), and "Prevention is not our mandate. But the potential is there. It is just blocked by law and credibility gaps" (Insurer, ID 12). Even diagnostic laboratories face rigid pricing models that disincentivize innovation: "You can't charge more than standard, even with better [technological tools]" (Diagnostics, ID 17), illustrating how outdated tariff structures penalize performance improvements. These governance challenges extend into the investment landscape for T2D prevention.

To avoid regulatory scrutiny, investors tend to favor "partly software" models that bypass FDA pathways (Investor, ID 24). Yet this risk aversion has structural consequences: the most scalable DHTs for T2D prevention may be the least embedded in traditional clinical practice. Our data suggests that entrepreneurs seeking to establish sustainable preventive health infrastructure may face a paradox. As one founder put it, "Prevention eliminates that recurring revenue" (Digital Health Entrepreneur, ID 26), suggesting that efforts to integrate DHT-based solutions in routine medical practice may be at odds with short-term financial incentives. Unless regulatory and reimbursement systems evolve alongside DHT innovation, high-impact technologies risk remaining marginal to formal healthcare delivery. Our analyses suggest that of the many of the identified DHTs with potential to advance T2D prevention, often operate at the edges of current regulatory and reimbursement frameworks (i.e., in standalone patient-facing wellness contexts), potentially highlighting the need for more adaptive governance models that can support innovation while ensuring accountability, patient safety, and value.

Discussion

Despite well-established scientific evidence for the prevention of T2D through sustained lifestyle change,[2–5] preventive programs are seldom integrated and sustained within traditional healthcare systems. How is the uptake and systemic implementation of prevention associated with stakeholder incentives, specifically between individuals, payers, and providers? Grounded in an ecosystem theory[8,34] and the e3-value ontology,[36,37] this is the first study, to our knowledge, that examines incentives among individuals, payers, and providers and the associations between DHT adoption and stakeholder value flows in the digital T2D prevention context.

Our findings support theoretical perspectives that prevention is contingent on a dynamic network of interdependent actors.[33,34] We identify three main insights. First, financial and non-financial incentives for lifestyle-based prevention are often temporally misaligned: engagement in lifestyle-based prevention may provide individuals with short-term benefits such as convenience, rewards, and improved health benefits, while payers are often motivated to support prevention programs as a function of long-term cost savings. Second, we find that DHT adoption for T2D prevention is associated with three main incentive patterns: personalization and convenience for individuals, value-based payment models for payers, and improving workflow efficiency for providers. DHTs may help support the realignment of stakeholder incentives through three key interrelated mechanisms: (i) sustaining individual engagement in prevention programs through personalized micro-incentives, (ii) supporting value-based payment models for payers, and (iii) automating workflows for providers. Using the e3-value framework, we visualize these reconfigured value exchanges (Figure 2), illustrating how DHTs may support a shared data-driven infrastructure to enhance individual engagement, performance tracking, and shared accountability across the ecosystem.[28]

Building on the stakeholder incentive literature,[10,13]our identification of varying financial and non-financial is consistent with perspectives that prevention incentives remain highly fragmented across stakeholder groups As detailed in Table 4, this fragmentation is particularly evident in the temporal dimension: individuals are primarily motivated to engage in lifestyle programs and prevention efforts based on short-term, tangible rewards such as cashback, gamified tokens, or convenience-enhancing lifestyle tracking apps (i.e., "Upload [photos of] your meals for today. You earn a few utility tokens," ID 23), In contrast, insurers and providers are more likely to prioritize delayed benefits like reduced readmissions or loyalty-based retention to their services and plans over extended periods of time, and at the

population level (Prior work examining incentives has specifically focused on provider reimbursement models and patient adherence to treatment plans, finding fragmented financial incentives among various healthcare stakeholders (i.e., pay-for-service models disincentivizing preventive care).[17]

Here, we also identified perceived trust in data fairness as an additional non-financial incentive for individuals to engage with DHTs for T2D prevention. This finding reframes data privacy, not as a compliance issue,[70] but as a potential behavioral motivator, potentially associated with willingness to engage with DHTs. For providers and payers, data privacy primarily functions as a regulatory compliance incentive, crucial for avoiding penalties and maintaining public trust. Furthermore, strong data privacy can also serve as a non-financial incentive for patient and customer acquisition or retention.

DHTs as potential incentive bridges

Building on prior research that positions DHTs as key enablers of value-based care,[21,71] our results suggest that DHTs may modify traditional fee-for-service payment models by linking reimbursement to continuous behavioral and clinical signals rather than discrete treatment encounters.[72] Early implementations of such models include engagement-contingent payments in digital prevention programs, shared-savings contracts between payers and provider organizations, and remote monitoring models rewarding individuals for sustained adherence to behaviors such as dietary logging, physical activity, or medication adherence.[73] For instance, providers may receive payments based on adherence metrics, while payers may gain earlier risk stratification and reduced uncertainty in future claims. Individuals can also be incentivized to maintain healthy behaviors through gamified feedback loops that reward sustained engagement.[74,75]

DHTs may enable real-time incentive mechanisms through gamification, biometric feedback loops, and micro-reward systems, illustrated by platforms such as Lark Health, Veri, and Supersapiens. Such micro-incentives may work by strengthening individuals' perceived benefits and self-efficacy to comply with lifestyle changes, as proposed by the Health Belief Model. However, these early, integrative cross-stakeholder models remain experimental and context-dependent, as healthcare systems frequently lack standardized data governance and near real-time interoperability across payers, providers, and technology vendors. Contractual frameworks that allow individual-level health and DHI engagement data to trigger automated reimbursement or benefit adjustments—capabilities that are essential for scaling prevention-oriented payment models,[24,70,76–78] are often lacking.

In turn, DHT-based companies increasingly aim to foster individual engagement and support performance-linked reimbursement models. Yet, such architectures also often run into legacy reimbursement structures. Recent evidence on AI-driven nutrition systems[79,80] similarly highlights the friction between technological implementation and institutional adaptability, underscoring the need for more responsive reimbursement frameworks that can accommodate algorithmic personalization, evolving data-governance requirements[81] (i.e., GDPR and HIPAA compliance). These examples show how digital advances challenge existing regulatory and payment structures, underscoring the need for adaptive governance and incentive models to sustain innovation.[80,82] Consistent with research on sociotechnical systems,[23,24] our findings suggest that successful implementation of prevention hinges not only on technological affordances but on stakeholder governance. DHT companies often lack alignment with payer timelines and face difficulty integrating into incumbent provider workflows, leading to implementation friction even when DHTs may be clinically validated.[28,31]

Overall, our findings extend the prior concept of intertemporal optimization in behavioral economics in health and payment models for chronic disease management[10,51,83] by uncovering temporal misalignments, where short-term user rewards drive engagement, yet long-term payer savings are insufficiently captured. By integrating a systematic literature review, market analysis, and expert interviews into a unified e3-value model, we provide: (1) a typology of stakeholder-specific incentives grounded in empirical data; (2) the identification of system-level misalignments at the intersection of business model design and incentive logic; and (3) a mapping of DHT-association-induced shifts in stakeholder roles and value.

For policymakers, the results suggest that hybrid models combining immediate user-facing incentives (i.e., usage-based rewards) with long-term shared savings arrangements may warrant further consideration. For developers, the evidence indicates that factors such as trust, perceived fairness, and adaptive recognition are not merely ancillary but essential for sustaining user engagement, particularly in direct-to-consumer models. Future research could examine how real-world responses are affected by implementing the recommended incentives alignment.

Limitations and future directions

This study has several limitations. First, while our 26 expert interviews offer deep insights into stakeholder incentives, the sample is geographically concentrated in Switzerland (11 out of 26), which may constrain the generalizability of findings to regions with distinct regulatory, financing, or cultural contexts, see Table A5 and Table A6. For example, although the sample included experts from diverse regions, representation from several high-growth DHT markets, particularly representation from Asia, was limited. Second, our market analysis focused primarily on

English-language materials from firms operating in high-income countries, which may underrepresent models and dynamics from major innovative low- and middle-income health systems, particularly those of China and India. As a result, our findings may not fully capture regional innovations or alternative approaches to T2D prevention. Third, while the study identifies patterns and theoretical associations between DHTs and stakeholder incentives, it does not establish causal effects.

Future research may experimentally evaluate the impact of DHT-enabled incentive mechanisms, such as outcome-based reimbursement, gamified adherence rewards, or real-time biometric feedback, on measurable endpoints, including user engagement, clinical outcomes (i.e., average blood sugar reduction), long-term adherence in preventive lifestyle programs, and long-term cost-savings. In addition to intervention studies, future work may fruitfully explore system-level simulations of the cost-effectiveness (both direct and indirect costs) of DHT adoption under various incentive configurations and policy regimes. In particular, comparative analyses across health systems should examine how incentive patterns identified in high-income settings translate to low- and middle-income countries, where fragmented financing structures, limited data infrastructure, and different reimbursement logics may constrain the implementation of value-based payment models and require localized adaptations of DHT-based prevention strategies.[84] In such settings, engagement-focused or community-based incentives may be more salient than payer-driven outcome contracts, suggesting that the observed patterns are context-dependent rather than universally transferable.

Conclusions

Scalable T2D prevention is most likely to succeed within ecosystems where individual, payer, and provider incentives are aligned. We find persistent misalignment of temporal incentives, which may hinder large-scale implementation. DHTs may support stakeholder alignment by directing personalized engagement in preventive interventions, promoting value-based reimbursement, and improving operational efficiency for providers. Sustained preventive impact, however, is likely associated with critical enablers: empirical evidence linking DHT prevention to health and cost outcomes, policy frameworks that reward preventive value creation, and DHT designs that prioritize trust and transparency. Realizing the potential of digital T2D prevention likely requires improved cross-sector coordination to align stakeholders and ensure these enabling conditions are met.

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Ethical approval

This study was conducted in accordance with the Checklist for Assessing the Ethical Soundness of Research Projects at the University of St Gallen and was exempt from a formal review and approval by the Ethics Committee of the University of St Gallen.

Author contributions

Wasu Mekniran: conceptualization, methodology, investigation, formal analysis, data curation, software, writing–original draft, and writing–review and editing. Wilma Diethelm: methodology, investigation, formal analysis, data curation, and writing–review and editing. Victoire Stalder: methodology, investigation, formal analysis, data curation, and writing–review and editing. Elgar Fleisch: investigation, supervision, writing– review and editing, and funding acquisition. Tobias Kowatsch: conceptualization, resources, supervision, writing–review and editing, and funding acquisition. Mia Jovanova: conceptualization, methodology, investigation, formal analysis, resources, supervision, writing–review and editing, and funding acquisition.

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Declaration of conflicting interests

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Data availability

The data sets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Guarantor

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Supplemental material

Supplemental material for this article is available online.

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Appendix

The appendices support the study's methodology and findings, including search protocols, coding framework, interviewee data, detailed transformation analyses, and funding distributions that expand on the market analysis.

Table A1. Search strategy for systematic literature review.

Database	Filter	Full search terms	Results
Science Direct	2010–2023, review articles and research articles, English	("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health")	37
EBSCOhost	2010–2023, peer-reviewed academic journals, English	Abstract: (("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health")) OR Title: (("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health")) OR Subject Terms: (("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health"))	108
Web of Science	2010–2023, Review article, English	Topic (title, abstract, author keywords): (("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health"))	15
IEEE Xplore	2010–2023, Journals, English	All Metadata (abstract, title, indexing terms): (("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health"))	68
ACM Digital Library	2010–2023, Research Article, English	AllField: (("business model" OR "health ecosystem") AND ("preventive care" OR "non-communicable" OR "chronic disease" OR "digital health" OR "electronic health"))	48

Table A2. Codebook.

Code label	Definition	Code group
External Factors	External environmental triggers or pressures that precipitate or necessitate BMI (Business Model Innovation), such as shifts in technological disruptions, or macroeconomic changes.	Antecedents
Internal Factors	Internal organizational resources, capabilities, or strategic shifts that enable or drive BMI, such as leadership changes, or evolving corporate strategies. Excludes external pressures.	Antecedents
Macro-Level	Broad institutional or environmental conditions that amplify or dampen BMI processes or outcomes, such as competition laws, regulatory frameworks, or geopolitical factors.	Moderators
Firm-Level	Organizational-level attributes that shape BMI implementation or success, including structural design, cultural norms, or values	Moderators
Micro-Level	Individual-level psychological or cognitive factors influencing BMI decision-making or execution, such as managerial cognition, behavioral biases, or personal motivations.	Moderators
Financial Performance	Tangible financial benefits resulting from BMI, such as revenue growth, profitability improvements, market share gains, or return on investment.	Outcomes
Innovativeness	Enhanced capacity for novelty or creativity stemming from BMI, such as the generation of new value propositions, product/service innovations, or competitive differentiation.	Outcomes
Cost Reduction	Efficiency gains from BMI leading to decreased operational, production, or transaction costs, such as streamlined processes or resource optimization.	Outcomes
What (Offering)	The core content of the BMI, defined as the product, service, or value proposition being innovated (i.e., changes in features, bundling, or quality).	Business Model
Who (Target Customer)	The customer-facing element of BMI, encompassing shifts in target segments, user needs, or relationship dynamics (i.e., from B2C to B2B or niche to mass markets).	Business Model
How (Delivery)	The operational mechanisms for providing the offering, including channels, logistics, platforms, or processes (i.e., digital vs. physical delivery, partnerships).	Business Model
Value (Revenue Model)	The economic logic of BMI, involving revenue streams (i.e., pricing, monetization models) and cost architectures (i.e., fixed vs. variable costs, resource allocation).	Business Model

Table A3. Interviewee roles ($n = 26$).

Role	ID	Position	Min
Political / humanitarian	1	Former president and founder, Medical Bariatric Association	32
Political/humanitarian	2	Founder, Medical School Longevity Program	22
Research	3	Researcher and university lecturer, Public Health	20
Manufacturer	4	Food technology expert, food ingredient supplier	25
Manufacturer	5	Digital health developer, Healthcare Information Technology	30
Payer/insurer	6	Innovation manager, Health Insurance	42
Payer/insurer	7	Transformation manager, Health Insurance	58
Payer/insurer	8	Innovation lab lead, Health Insurance	49
Payer/insurer	9	Chief information officer, Health Insurance	53
Payer/insurer	10	Head of open innovation, Health Insurance	25
Payer/insurer	11	Product manager, Health Insurance	25
Payer/insurer	12	Chief executive officer, Health Insurance	45
Payer/insurer	13	Head of services and products, executive board member, Health Insurance	37
Payer/insurer	14	Lead, Corporate Foresight, Intelligence and Development, Health Insurance	48
Payer/insurer	15	Board member, Health Insurance	42
Healthcare provider	16	Physician, Academic Hospital	20
Healthcare provider	17	Medical laboratory technologist, Diagnostic Center	45
Healthcare provider	18	Inpatient nurse and nurse informatics team leader	30
Healthcare provider	19	Expert nutritionist	31
Healthcare provider	20	Executive, Life and Health Coach	22
Healthcare provider	21	Physician specializing in endocrinology	25
Healthcare provider	22	Expert, Metabolomics and Precision Medicine	24
Support community	23	Pharmacist and content strategist	19
Investor/consultant	24	Investment analyst	20
Investor/consultant	25	Owner/principal, Medical Wellness Agency	27
Investor/consultant	26	Chief executive officer, Digital Health Entrepreneur	27

Table A4. The transformation patterns enabled by DHT with sample companies and quotes.

Transformation patterns	Traditional role	Evolving role	Mentioned incentives	Sample companies	Sample quotes
(A) Adaptive Incentive Structures	Software infrastructure provider	Builds end-user applications embedding prevention logic within the user experience.	Scalable, low-cost health literacy; expansion of market reach.	Omada Health, Noom, Oviva, Vively	"We should provide the cheapest and easiest way … the future is going more and more towards digital." (DHT Developer, ID 5)
	Reimburser; governmental payer; risk pool manager; claims administrator; price-sensitive payer	Offers digital prevention programs; integrates fitness tracking and adherence bonuses; pilots digital self-assessment; uses dynamic digital rewards; partners with digital health platforms.	Loyalty and behavior change; legal separation of incentives (basic vs. supplementary); lock-in and lifestyle relevance; prevention cost savings; medication adherence and generics uptake.	Lark Health, 9amHealth, Vida Health, FULLFILL	"… where we promote and reward healthy behavior." (Insurer, ID 6); "We remunerate the doctor … if he makes sure that some people adhere to the standards." (Insurer, ID 7); "We now shift towards being a companion for all aspects of health." (Insurer, ID 8); "If you use this app, you collect points… discounts, vouchers." (Insurer, ID 9); "Motivate more through performance than just price." (Insurer, ID 13).
	Pharmacist	Develops gamified self-tracking with tokens and open-source architecture.	Behavior incentives; platform data acquisition.	Supersapiens, Veri, Fitterfly	"Upload your meals for today. You earn a few utility tokens." (Content Strategist, ID 23)
	Founder	Builds AI-driven personalized prevention systems.	Systemic change via data infrastructure for improved prevention outcomes.	Human Longevity, Digital Diagnostics, Digbi Health	"For prevention to really make an impact, we need structural changes." "Poor data leads to inconclusive results." (Digital Health Entrepreneur, ID 26)
(B) Expanded roles for non-traditional providers	Medical association founder	Builds global digital education platforms and vets digital products.	Scalable trust infrastructure; quality assurance.	Fruit Street, Fitterfly	"We would almost be a trust layer … vet a product and say this is good based on research." (Association Founder, ID 1)
	General Practitioner (GP) in a constrained system	Utilizes social media as a public health tool.	Assumes an outreach role using digital channels; public health education.	BeatO, Breathe Wellbeing	"My initiative is to educate the people through social media as my responsibility." (Community Physician, ID 2)

(continued)

Table A4. Continued.

Transformation patterns	Traditional role	Evolving role	Mentioned incentives	Sample companies	Sample quotes
	Academic researcher	Supports digital health strategy design for prevention.	Validates DHT legitimacy; promotes health literacy; collaborative research.	Glooko, Companion Medical	"We should collaborate with primary care." "We educate medical students and high school students." (Public Health Researcher, ID 3)
	Backend technologist	Builds Software Development Kits (SDKs); partners with wearable technology companies	Supports vulnerable populations through app design; broader data integration.	BOYDSense, DiaMonTech,	"The end goal is to define interventions that help vulnerable people." (DHT Developer, ID 5)
	Passive payer; service-dependent payer; health insurer	Venture investor and co-developer of digital services; ecosystem connector; integrated vendor ecosystem and digital services for firms.	Repositioning as a healthcare partner via digital ecosystem logic; access to innovation via DHT partnerships; expansion into health services.	Livongo by Teladoc, Caristo Diagnostics	"We want to play a role as a healthcare partner for our customers." (Insurer, ID 6); "Technology companies … are super active with their platforms and collect valuable prevention data." (Insurer, ID 6); "The ecosystem idea of connecting existing offerings … is very promising." (Insurer, ID 8); "We offer case and care management, health coaching, and prevention services to firms." (Insurer, ID 9).
	DHT startup	Standardizes AI solutions; improves wearable data quality	Long-term value via prevention infrastructure; market leadership.	Tesis Biosciences, Digital Diagnostics, Eyenuk	"Focuses on standardizing AI solutions." (Digital Health Entrepreneur, ID 26)
(C) Evolving regulatory considerations for digital prevention tools	Tech-focused, separate from governance	Must comply with app store policies, EU GDPR, and ethics board requirements; faces gatekeeping by major platforms (Apple/Google).	Compliance burden; limited resources for smaller teams; search for scalable, compliant development environments.	Oviva	"Apple and Google Play store policies constrain smaller teams." "Only bigger teams with funding succeed." (DHT Developer, ID 5)
	Payer with claims processing role; basic benefits administrator	Uses supplementary insurance and co-marketing to bypass restrictions for DHTs;	Regulatory constraints on data use and prevention funding; seeking systemic change toward	Oviva	"We are not allowed to use our customer data for marketing." (Insurer, ID 6); "We were

(continued)

Table A4. Continued.

Transformation patterns	Traditional role	Evolving role	Mentioned incentives	Sample companies	Sample quotes
		advocates for data integration; pilots DHTs via bundled care outside.	capitation and integrated care models.		forbidden to do that … we are not allowed to approach customers in the OKP." (Insurer, ID 7); "We actually know the medications someone is taking … but we are not allowed to address it." (Insurer, ID 7); "Prevention is not our mandate. But the potential is there. It's just blocked by law and credibility gaps." (Insurer, ID 12).
	Price-capped laboratory	Pushes for faster validation of digital diagnostics (i.e., home kits, EHR links).	Regulatory rigidity prevents innovation scaling.	Caristo Diagnostics, Toku Eyes	"You can't charge more than standard—even with better PCR." (Diagnostics, ID 17)
	Capital allocator	Avoids heavily regulated DHTs (i.e., FDA-classified medical devices).	Preference for software-based, low-regulation models; higher return on investment.	Omada Health	"As long as it's partly software and doesn't go through FDA." (Investor, ID 24)
	Independent innovator	Seeks DHT-enabled wellness infrastructure.	Venture capital models and reimbursement systems discourage prevention	Vida Health	"Prevention eliminates that recurring revenue." (Digital Health Entrepreneur, ID 26)

This table maps selected firms from the market analysis to the evolving roles identified, showing how different venture types apply engagement, value-based, and automation incentives across the prevention ecosystem.

Table A5. Distribution of identified incentive patterns across funding stages.

Incentive pattern	Seed	Early	Late	Post-IPO	M&A	Private equity
Adaptive Incentive Structures (A)	1	6	3	1	0	3
Expanded Roles for Non-Traditional Providers (B)	0	7	1	0	1	3
Regulatory Considerations (C)	0	2	1	1	0	1

Table A6. Distribution of identified incentive patterns across geographic regions.

Incentive pattern	USA	Europe	India	Oceania
Adaptive Incentive Structures (A)	10	3	1	1
Expanded Roles for Non-Traditional Providers (B)	7	3	3	0
Regulatory Considerations (C)	2	2	0	1

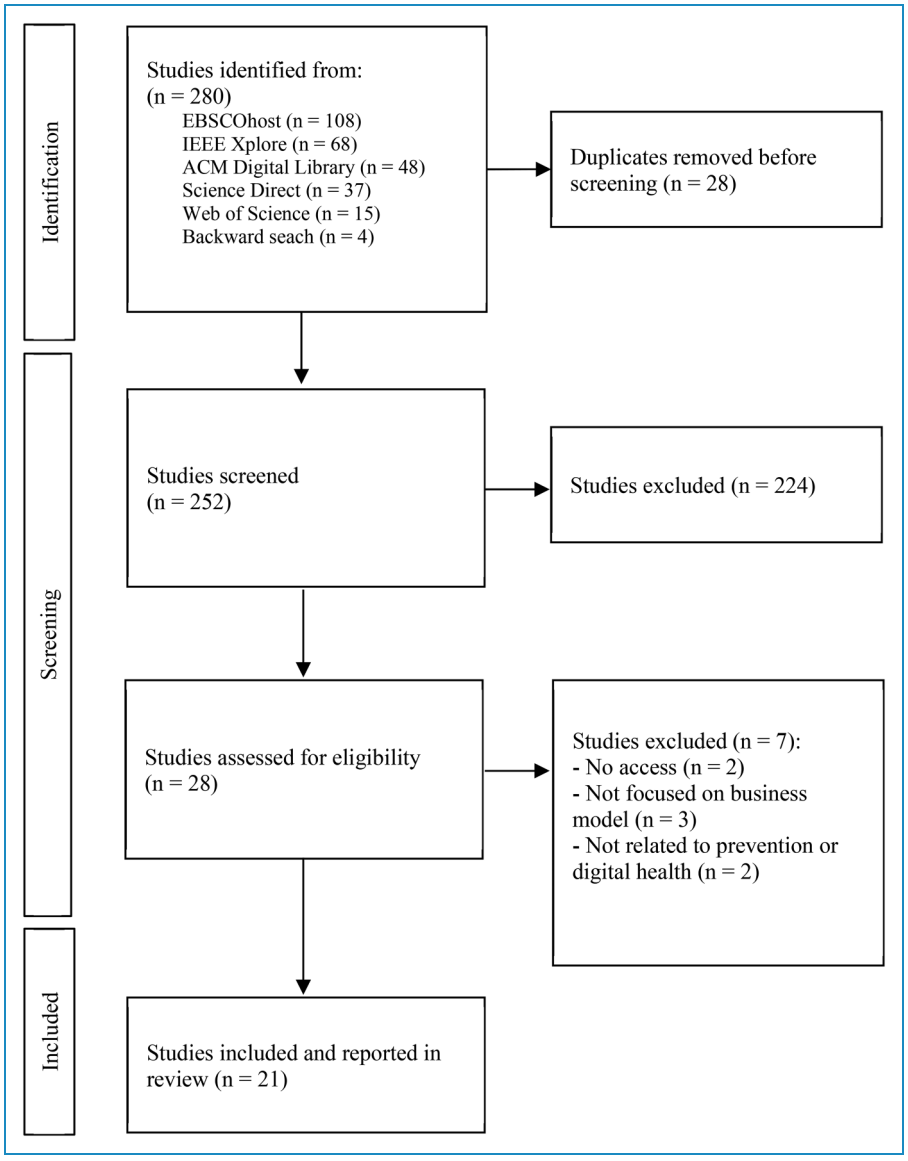

Figure A1. The PRISMA flow diagram illustrates the data extraction process.

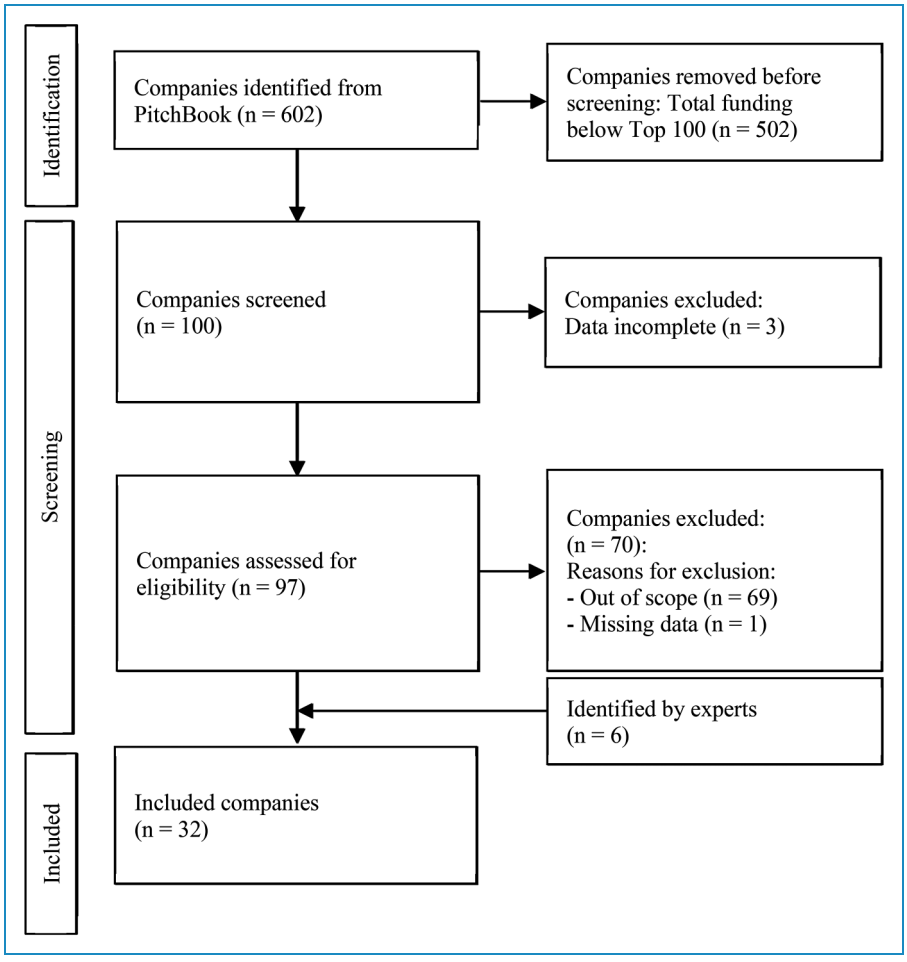

Figure A2. The flow diagram illustrates the company identification process for market analysis.