Deciphering the mechanism of action of digital therapeutics in obesity to enable identification of optimal individualised dosing and just in time adaptive interventions

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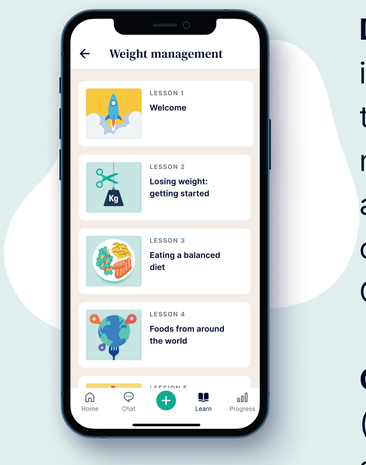
Introduction

Digital therapeutics (DTx) are evidence-based interventions for weight management. However, unlike pharmaceuticals with defined biological pathways and pharmaceutical doses, the "mechanism of action" (MoA) and optimal "dosing" of digital behavioural interventions remain poorly characterised[1].

Transitioning from static digital pathways to precision obesity care requires identifying which "active ingredients", such as self-monitoring frequency or feedback loops, drive clinical outcomes and defining the specific dose-response thresholds necessary for clinical effectiveness.

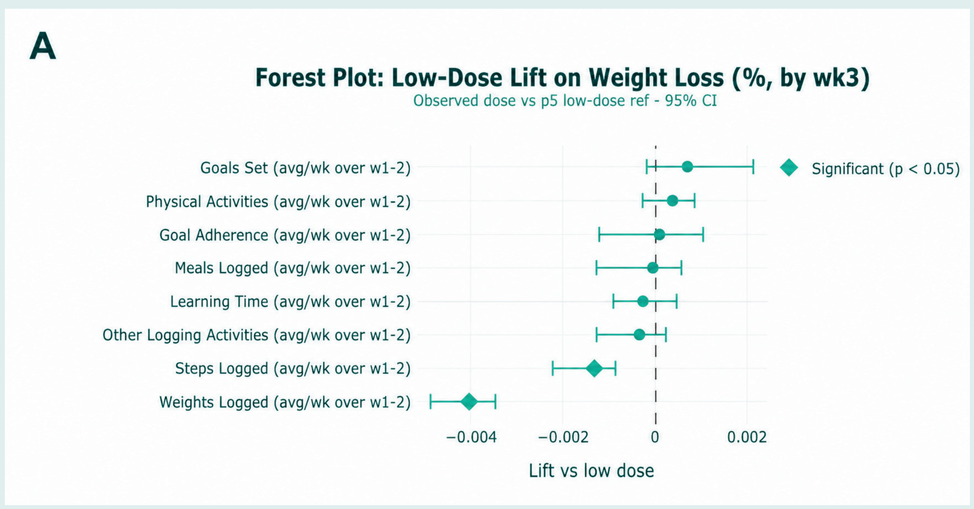
Method

A multi-methodological approach was employed using real-world data from a German-reimbursed digital health application (DiGA) for obesity (12-week intervention).

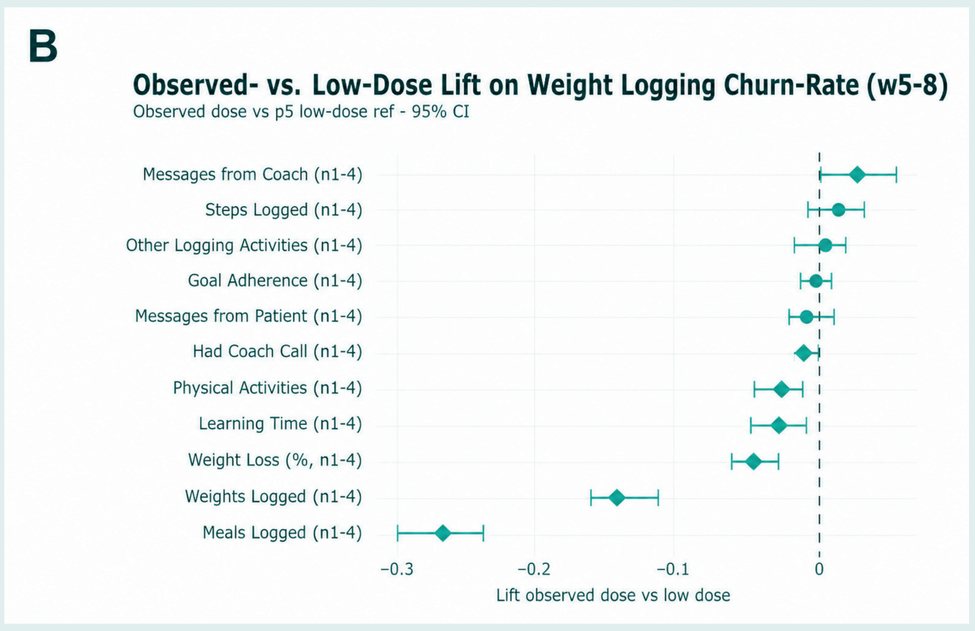


Dose-Response Modelling: To enable causal inference, a Directed Acyclic Graph (DAG) modelled the interplay between therapeutic inputs (self-monitoring, feedback, education, action planning) and patient characteristics. Analysis included 12,329 cases with prescriptions initiated between April and October 2025.

Controlled AI Experiments: Randomised A/B tests (N=5,000) compared generic communication against automated, AI-generated weekly summaries. These summaries utilised Large Language Models (LLMs) to synthesise multimodal data, including nutritional logs and coach-patient chat history, into personalised feedback. Clinical safety was ensured via a secondary AI-evaluator prompt.



A and B: Causal drivers of early weight loss (A) and early weight logging churn prevention (B). Negative values indicate reduction of weight and reduction of churn probability in percent point/100. Graphs show the causal effects of the actual observed engagement in contrast to a hypothetical low dose defined by the lowest 5% of observed engagement.

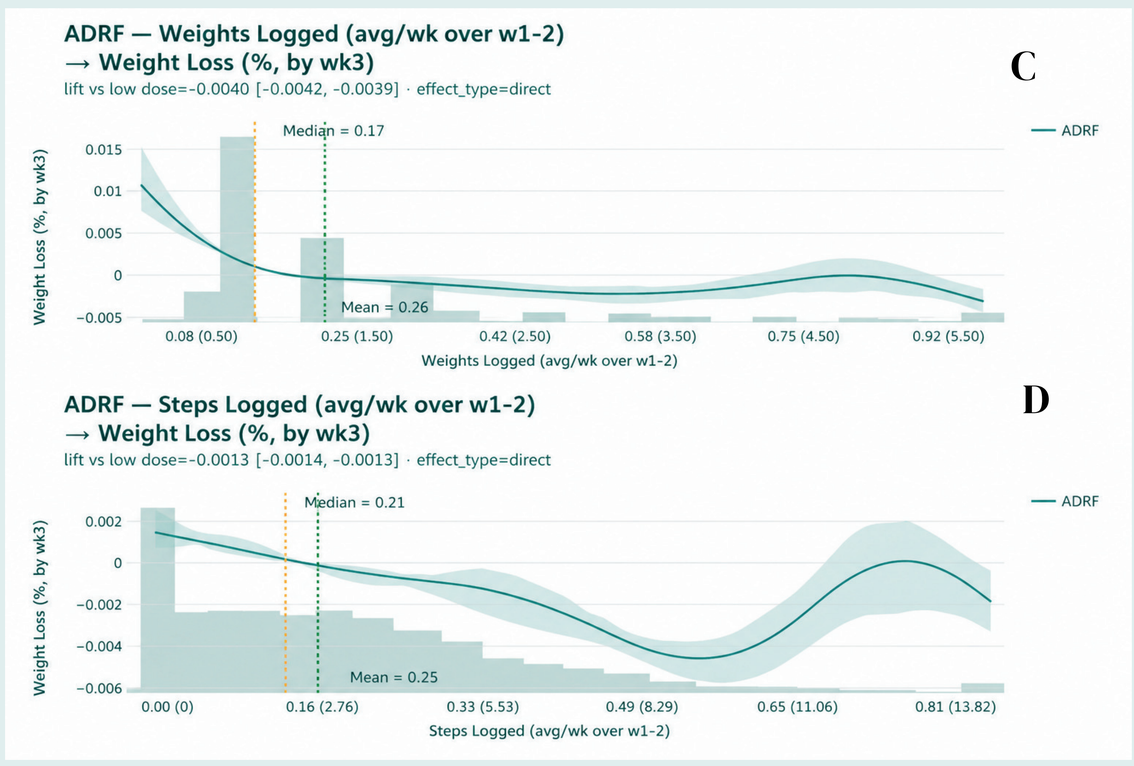


Results

Causal dose-response modeling identified optimal dosing requirements for both cohorts and individuals. The framework determined how actionable engagement patterns mediate the effects of fixed characteristics like age and gender. This enabled the identification of engagement dosages required to achieve minimal clinically important differences (MCID) in outcomes and pinpointed root causes of weight stagnation to guide mitigation strategies.

A/B tests demonstrated that "one-size-fits-all" engagement increases chat volume without improving retention.

Conversely, AI-driven personalised feedback significantly optimised the effective "dose" received. Personalised weekly summaries increased Week 3 engagement by 8.7% and Week 4 retention by 3.7%. Enhanced behaviour-specific feedback achieved a +16% cumulative engagement uplift over baseline, suggesting that personalised, ecological momentary interventions act as a catalyst, increasing the effectiveness of dose of behavioural change techniques.



C and D: Average Dose Response Function (ADRF, turquoise) of Step logging in week 1 and 2 (D, raw unit=1000/per day) and Weight logging in week 1 and 2 (C, average logs per week) on early weight loss (Journey Week 3). Mark labels are given in percentiles of the population (raw values in brackets). Additionally to ADRFs, histograms in light grey indicate observed frequencies of a specific dose.

Discussion and conclusion

Shifting from volume-based engagement metrics toward individualised dosing is essential for scalable obesity care.

By leveraging AI for ecological momentary interventions and Just-in-Time Adaptive Interventions (JITAI), DTx can transition from static pathways to dynamic, responsive models that deliver the right intervention at the right time.

This research provides a blueprint for using real-world data to refine the therapeutic window of digital obesity treatments.

References

1. Schmidt, L.; Langenberger, B.; Schirmann, F.; Reif, S.; Stern, A. D. Mechanisms of Action for Digital Therapeutics. npj Digit. Med. 2026, 9 (1), 274. https://doi.org/10.1038/s41746-026-02502-y.

Conflict of Interest: LS, FS, JD, AK are employees of Oviva AG.