

# Associations Between Engagement with the BitHabit Digital Lifestyle Intervention and Changes in Type 2 Diabetes Risk Factors

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**Abstract.** Type 2 diabetes (T2D) can be prevented or delayed through a healthy lifestyle. Digital behavior change interventions (DBCIs) may offer cost-effective and scalable means to support lifestyle changes. This study investigated associations between user engagement with a habit-formation-based DBCI, the BitHabit app, and changes in T2D risk factors over 12 months in 963 participants at risk of T2D. User engagement was characterized by calculating use metrics from the BitHabit log data. User ratings were used as a subjective measure of engagement. The use metrics and user ratings were the strongest associated with improvements in diet quality. Weak positive associations were observed between the use metrics and changes in waist circumference and body mass index. No associations were found with changes in physical activity, fasting plasma glucose, or plasma glucose two hours after an oral glucose tolerance test. To conclude, increased use of the BitHabit app can have beneficial impacts on T2D risk factors, especially on diet quality.

**Keywords.** Diabetes, digital health intervention, effective engagement, eHealth

## 1. Introduction

Type 2 diabetes (T2D) affects 6.3% of the world's population of all ages, and its prevalence is increasing [1] even though it could be prevented or delayed through a healthy lifestyle. Digital behavior change interventions (DBCIs) may provide scalable and cost-effective means to support lifestyle changes [2]. Some minimum amount of engagement with a DBCI is required for the intervention to invoke beneficial health

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outcomes. However, sufficient amount and type of engagement, i.e., effective engagement, in different settings is not completely understood [3]. Previously, we developed a DBCI, the BitHabit app, containing a large library of healthy small actions (habits), to support adoption and maintenance of healthy habits among people at risk of T2D [4]. The current study aimed to investigate associations between user engagement with the BitHabit app and changes in T2D risk factors.

## 2. Methods

This study included 963 participants from the StopDia study which evaluated the effectiveness of the BitHabit app in a 12-month randomized controlled trial in a population at risk of T2D (55±10 years [mean ± SD], 78% female) [4]. User engagement was characterized by calculating use metrics from the BitHabit log data: number of use days during the first month and study period and number of days with reported habit performances. User ratings after one to two month's use were used as a subjective measure of engagement. Outcome variables included changes in diet quality (DQ), physical activity (PA), waist circumference (WC), body mass index (BMI), fasting plasma glucose (FPG), and plasma glucose two hours after an oral glucose tolerance test (2h PG). Magnitude of associations between user engagement and changes in T2D risk factors was evaluated with linear regression, adjusted for baseline value of the outcome. The StopDia study was approved by the Research Ethics Committee of the Hospital District of Northern Savo (Statement 467/2016) and was conducted according to the Declaration of Helsinki and the Responsible Conduct of Research by the Finnish Advisory Board on Research Integrity.

## 3. Results and Discussion

The BitHabit app was used on a median of 5 (inter-quartile range, IQR, 3-10) days during the first month and 40 (IQR 12-71) days during the study period. The participants reported on a median of 375 (IQR 49-1149) performed habits. All user engagement metrics and user ratings were positively associated with DQ. Number of use days during the study period was also positively associated with WC and BMI. No associations were found with changes in PA, FPG, or 2h PG. In conclusion, an increased use of the BitHabit app can have beneficial impacts on T2D risk factors, especially on DQ.

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