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Motivational Composition in Digitally Supported and Conventional Prevention Programs: A Three-Wave Study Based on Self-Determination Theory

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Abstract

Background

Digital health interventions offer potential solutions to accessibility barriers in occupational prevention programs, yet their impact on motivational quality remains underexplored. Self-Determination Theory (SDT) posits that autonomous motivation - driven by personal values rather than external pressures - is critical for sustained health behavior change. This study compared motivational composition between digitally supported and conventional prevention programs within the German Pension Insurance system and examined whether autonomous motivation predicts program attendance.

Methods

In a longitudinal quasi-experimental study, 163 employed adults (mean age 51.7 years, 69% female) participated in either a digitally supported prevention program (n = 96; 14-day inpatient stay plus 6-month digital aftercare) or a conventional RV Fit program (n = 67; four-phase in-person format over 24 weeks). Motivational composition was assessed using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2) to calculate the Relative Autonomy Index (RAI) at baseline, 12 weeks, and 24 weeks. Self-reported program attendance was measured at 12 and 24 weeks. Repeated measures ANCOVA examined group differences in motivational trajectories controlling for age and gender. Multiple linear regression analyses tested whether autonomous motivation predicted attendance.

Results

A significant time-group interaction emerged ($F(2,316) = 4.51$, $p=.012$, $\eta^2=.028$), indicating divergent motivational trajectories. The digitally supported group showed continuous decline in RAI from baseline (M = 13.37) through 12 weeks (M = 12.13) to 24 weeks (M = 11.82). The conventional group showed initial increase to 12 weeks (M = 13.77) followed by decline to 24 weeks (M = 12.68). Despite lower motivational quality, the digitally supported group reported significantly higher attendance at both 12 weeks (10.27 vs. 7.92 weeks, $p=.001$) and 24 weeks (18.75 vs. 13.56 weeks, $p<.001$). Autonomous motivation did not significantly predict attendance in either model; group assignment was the strongest predictor.

Conclusions

While digitally supported prevention programs achieved higher participation rates, they were associated with declining autonomous motivation compared to conventional formats. These findings suggest that structural advantages of digital delivery do not automatically translate to sustained motivational quality. Digital health platforms should be explicitly designed to support basic psychological needs - particularly relatedness and competence - to ensure increased reach translates into long-term behavior change effectiveness.

Trial Registration: The study was pre-registered with the German Clinical Trials Register on February 12 2021 (Registration number: DRKS00022550).

Introduction

Maintaining a healthy and productive workforce has become increasingly challenging in the context of profound demographic shifts. Germany, like many industrialized nations, faces a rapidly aging population with a shrinking proportion of working-age individuals, a trend projected to intensify through 2070 [1]. This demographic transition is accompanied by rising prevalence of chronic health conditions and an increasing demand for medical rehabilitation services [2]. The consequences extend beyond individual health: lifestyle-related risk factors such as physical inactivity, obesity, and stress compromise work ability, reduce productivity, and contribute to premature exit from the workforce [3, 4]. In response to these challenges, prevention programs have emerged as a strategic priority for maintaining employability and workforce health [5]. Within this framework, the German Pension Insurance system plays a central role by offering evidence-based prevention measures designed to preserve and enhance the work capacity of insured employees at risk for health-related work limitations.

Among the prevention initiatives aimed at maintaining workforce health, the German Pension Insurance offers RV Fit, a nationwide multicomponent program targeting employed individuals at risk for work-related health limitations [6]. The program integrates physical activity, nutrition, and stress management components to address common occupational health risks. Evidence from meta-analyses indicates that workplace health promotion and prevention programs can effectively improve health behaviors, reduce risk factors, and enhance work-related outcomes [7–9]. However, despite these positive outcomes, the conventional delivery model presents several practical challenges. Conventional in-person formats create barriers related to geographic accessibility, particularly in rural regions, and pose scheduling difficulties for working participants who must balance program attendance with employment responsibilities. Additionally, concerns exist regarding adherence during self-directed phases, when participants are expected to maintain health behaviors independently without ongoing professional support [10].

Digital health interventions have emerged as a promising strategy to address some of the access and engagement barriers inherent in conventional in-person health promotion programs. Advances in mobile and web-based technologies have enabled the delivery of prevention and health promotion interventions across diverse health domains, including cardiovascular disease prevention, mental health, and physical activity promotion [11–13]. Systematic reviews and meta-analyses provide evidence for the effectiveness of digital health interventions in improving health behaviors and clinical outcomes, with some studies also demonstrating cost-effectiveness compared to traditional delivery formats [13–15]. Recent evaluations of RV Fit have demonstrated significant improvements in work ability and mental health among participants [16]. For workplace prevention programs, digital formats offer several potential advantages: they can overcome geographic barriers by providing remote access, allow participants greater flexibility in timing and location of engagement, and enable extended support

periods that may facilitate sustained behavior change [17, 18]. However, despite these benefits, questions remain about the long-term effectiveness of digital interventions, particularly regarding sustained engagement and maintenance of health behaviors beyond the initial intervention period [17, 19]. Understanding the mechanisms that support or hinder sustained participation in digitally supported prevention programs is therefore critical for optimizing their design and implementation.

Self-Determination Theory (SDT) provides a conceptual framework particularly suited for explaining why individuals initiate and maintain engagement in prevention programs [20]. SDT emphasizes the quality of motivation, conceptualizing human behavior along a continuum from controlled to autonomous regulation. According to SDT, extrinsic motivation exists along a continuum of self-determination, ranging from controlled to autonomous regulation. Controlled forms of extrinsic motivation include external regulation (behavior driven by rewards or punishments) and introjected regulation (behavior motivated by guilt or shame), while autonomous forms of extrinsic motivation include identified regulation (conscious valuing of a goal) and integrated regulation (full assimilation of values with the self). Intrinsic motivation, characterized by engagement for inherent interest and enjoyment, represents a distinct form of motivation that is fully autonomous and not extrinsically motivated. Amotivation, reflecting a complete lack of intention to engage in behavior, exists outside this continuum. Meta-analytic evidence consistently demonstrates that more autonomous forms of motivation—both autonomous extrinsic motivation and intrinsic motivation—are associated with greater initiation and maintenance of physical activity and other health behaviors [21, 22]. Furthermore, interventions designed to foster autonomous motivation through supporting individuals' basic psychological needs for autonomy, competence, and relatedness have been shown to produce improvements not only in motivational quality but also in health behaviors and physical and mental health outcomes [23]. For prevention programs aiming to achieve long-term behavior change, these findings suggest that the degree to which participation is autonomously motivated, rather than driven by external pressures or internal guilt, may be critical for sustained adherence and lasting health benefits.

Digital health interventions present both opportunities and challenges in the context of SDT, with the potential to either support or frustrate the basic psychological needs that underpin autonomous motivation. Despite the growing body of evidence on the clinical and behavioral effectiveness of digital health interventions, systematic reviews have rarely examined motivational composition as an outcome. Consequently, it remains unclear whether digitally supported prevention programs foster motivational quality comparable to, or different from, conventional in-person formats, and whether any differences in motivational composition might explain variations in program attendance.

The present study addresses this gap by comparing motivational composition between a digitally supported and a conventional prevention program within the German Pension Insurance system. Specifically, we compare participants in a digitally supported RV Fit program featuring a 14-day inpatient phase followed by six months of a digitally supported training phase with participants in the conventional RV Fit program consisting of multiple in-person phases over 24 weeks. While prior research has demonstrated comparable improvements in work ability and mental health outcomes between these

delivery formats [16], the motivational processes underlying these outcomes remain unexplored. This study has two aims: First, to compare the motivational composition between the digitally supported and conventional programs across three time points over 24 weeks. Second, to examine whether autonomous motivation predicts program attendance. Given the limited prior research directly comparing motivational trajectories between digital and conventional prevention formats, we adopt an exploratory approach regarding the direction of group differences. However, based on SDT principles and meta-analytic evidence [21–23], we hypothesize that higher autonomous motivation will be associated with greater program attendance. Understanding how delivery format influences motivational quality has important implications for the design and implementation of prevention programs aimed at achieving sustained behavior change in working populations.

Methods

Study Design

This longitudinal comparative study was pre-registered with the German Clinical Trials Register (DRKS; registration number: DRKS00022550; registration date: February 12 2021). The investigation utilized a quasi-experimental design comparing two prevention program delivery formats across a 24-week period, with assessments conducted at baseline (t0), mid-intervention at 12 weeks (t1), and post-intervention at 24 weeks (t2). Participants in the digitally supported condition engaged with a platform-based program, while those in the conventional condition participated in the standard RV Fit program. Random assignment to conditions was not implemented, as the ethics committee determined that restricting participant choice of program format would be ethically problematic.

All participants completed an initial inpatient stay at a prevention clinic, during which baseline assessments (t0) were administered. The study team distributed questionnaire packets containing study instruments, consent documentation, and contact information forms during this clinic phase. Completed materials were collected by clinic staff and forwarded to the research team at the Karlsruhe Institute of Technology, where all data handling followed institutional data protection protocols. For the 12-week (t1) and 24-week (t2) follow-up assessments, participants received questionnaire materials directly from the research team via their preferred mode of delivery, either electronic distribution or postal mail with prepaid return envelopes. This assessment protocol was standardized across both study conditions to ensure procedural equivalence. Data collection spanned from October 2019 through December 2021.

All study procedures adhered to ethical principles outlined in the Declaration of Helsinki. The study protocol, including data protection measures and informed consent procedures, received approval from both the Data Protection Officer and the Ethics Committee of the Karlsruhe Institute of Technology.

Sample

Across all three measurement points, data for the RAI was collected from 245 participants (147 in the digitally supported group, 98 in the conventional group) at baseline (t0), 186 participants (115 in the digitally supported group, 71 in the conventional group) at mid-intervention (t1) and 188 participants (111 in the digitally supported group, 77 in the conventional group) at the end of the intervention (t2).

The analytical sample used for all analyses consisted of the 163 participants who completed the motivation questionnaire at all three measurement time points over the 24-week study period. These participants were recruited from four prevention clinics within the German Pension Insurance system. The digitally supported group (n = 96) was recruited exclusively from the Knappschafts-Klinik Borkum, where the platform-based program was implemented. The conventional group (n = 67) was recruited from three clinics offering the standard RV Fit program: the Ambulantes Zentrum für Rehabilitation und Prävention am Entenfang GmbH in Karlsruhe, Alice Park Reha GmbH in Darmstadt, and Fachkliniken Sonnenhof GmbH in Höchenschwand.

Eligibility criteria required that participants be currently employed with a minimum of 15 hours per week, insured through the German Pension Insurance, and voluntarily enrolled in a prevention program. All participants provided written informed consent prior to study enrollment.

Interventions

Both prevention programs were administered over a 24-week period under the supervision of certified therapists. All participants received individualized training plans developed by qualified physiotherapists based on their specific health profiles and prevention goals. Therapists maintained ongoing oversight throughout both programs to monitor participant progress and address any adverse effects that might arise from the prevention activities.

Digitally Supported Prevention Program

The digitally supported prevention program combined an initial intensive inpatient phase with extended digital aftercare support. Participants began with a 14-day residential stay at the Knappschafts-Klinik Borkum, during which they completed the initial assessment, training introduction, and refresher components in a condensed format. During this inpatient period, therapists conducted comprehensive health assessments and collaboratively developed personalized training plans with each participant, establishing individualized prevention goals and exercise protocols.

Following the inpatient stay, participants received six months of structured digital aftercare through a web-based prevention platform. This platform provided continuous access to participants' individualized training plans, including detailed exercise descriptions and guidance. A key feature of the digital aftercare was ongoing therapeutic support: participants could communicate directly with the therapist team through the platform to clarify exercise techniques, report difficulties, or request modifications to their training regimen. Therapists monitored participant engagement and proactively adjusted training

plans as needed based on participant feedback and progress. Participants who showed extended periods of inactivity received encouragement from the intervention team to maintain engagement with the program.

Conventional Prevention Program

The conventional RV Fit program followed a four-phase structure delivered entirely through in-person contact over the 24-week intervention period. The initial phase consisted of several days of ambulatory medical assessment and counseling, during which participants received comprehensive health evaluations and behavioral coaching. Based on these assessments, therapists established individualized prevention goals and documented them in personalized training plans. Participants also attended educational sessions focused on health behavior modification strategies, particularly related to increasing physical activity.

The training phase extended over approximately two to three months, during which participants attended supervised exercise courses at their local prevention facility. These sessions were scheduled to accommodate working participants' schedules, typically offering one to two sessions per week. The courses were designed to support participants in achieving their established prevention goals through guided practice of recommended activities.

Following the supervised training phase, participants entered a self-initiative phase lasting approximately three months. During this phase, participants were expected to independently maintain and apply the health behaviors learned during the training phase, without ongoing professional supervision. The program concluded with a refresher phase, in which all participants reconvened as a group for one or more days. This final phase provided an opportunity for participants to reflect on their experiences throughout the entire prevention program and evaluate their progress toward prevention goals.

Measures

Motivational Composition

Motivational composition was assessed using the German translation of the Behavioral Regulation in Exercise Questionnaire-2 [24]. This 19-item self-report instrument measures different forms of motivation along the self-determination continuum proposed by Self-Determination Theory [20]. The questionnaire was adapted to assess motivation specifically for participation in prevention program activities rather than general exercise behavior. Participants responded to items using a 5-point Likert scale ranging from 1 (not true for me) to 5 (very true for me). The questionnaire comprises five subscales assessing distinct motivational regulations: intrinsic motivation (4 items), identified regulation (4 items), introjected regulation (3 items), external regulation (4 items), and amotivation (4 items).

To obtain an overall index of motivational quality, the Relative Autonomy Index (RAI) was calculated using the standard weighting procedure [24]. Intrinsic regulation scores were multiplied by 3, identified regulation by 2, introjected regulation by − 1, external regulation by − 2, and amotivation by − 3. Weighted scores were then summed, with higher positive RAI values indicating more autonomous motivation and lower or negative values indicating more controlled motivation or amotivation. The BREQ-2 was administered at all three measurement time points (t0, t1, t2).

In a health care professional student sample (n = 296), Mahony et al. [25] reported satisfactory internal consistencies for the BREQ-2 subscales, with Cronbach's α = .88 for intrinsic regulation, .83 for identified regulation, .77 for introjected regulation, .77 for external regulation, and .60 for amotivation. These values support the reliability of the BREQ-2 for assessing differentiated motivational regulations in health-related contexts.

Program Attendance

Program attendance was assessed through participant self-report at the 12-week (t1) and 24-week (t2) measurement points. Participants indicated their participation frequency by reporting the number of weeks during which they engaged in at least one prevention activity session. This measure provided information about consistency of engagement with the prevention program over time.

Statistical analyses

Statistical analyses were conducted using R (Version 4.5.1;[26]) in RStudio (Version 2025.05.1;[27]). All tests were performed with a significance level of α = .05.

Data Preparation

Preliminary analyses examined the distribution of study variables and calculated descriptive statistics, including means, standard deviations, and frequency distributions, for all variables. Independent samples t-tests were used to compare continuous baseline variables between groups, while chi-square tests examined differences in categorical variables. If variances in continuous variables were not homogeneously distributed, Welch's t-test was computed to account for heterogeneity.

For the attendance frequency variable, data plausibility checks were implemented to ensure reported values fell within feasible ranges. Given the assessment timing and potential postal delays, maximum attendance was capped at 16 weeks for the t1 measurement (12-week assessment point plus 4-week buffer) and 28 weeks for the t2 measurement (24-week assessment point plus 4-week buffer). Additionally, when participants reported fewer weeks of attendance at t2 compared to t1, the t1 value was carried forward to t2, as attendance weeks are cumulative.

Primary Analyses

To examine differences in motivational composition between the digitally supported and conventional programs across the three measurement points, we first conducted a repeated measures analysis of variance (ANOVA) with RAI as the dependent variable, time (t0, t1, t2) as the within-subjects factor, and group (digitally supported vs. conventional) as the between-subjects factor. This initial analysis examined the main effects of time and group, as well as the time-group interaction.

Subsequently, we conducted a repeated measures analysis of covariance (ANCOVA) that extended the initial model by introducing age as a covariate and gender as an additional between-subjects factor. This model examined main effects of time, group, and gender, two-way interactions (time-group, time-gender, group-gender), and the three-way interaction (time-group-gender).

For both analyses, assumptions of sphericity were tested using Mauchly's test, with Greenhouse-Geisser corrections applied when the sphericity assumption was violated. Additional assumptions of normality and homogeneity of variance were examined. Effect sizes were reported as partial η^2.

In the case of a significant time-group interaction, post-hoc analyses were conducted to interpret the interaction pattern. Pairwise comparisons across time points within each group were performed using paired t-tests with Bonferroni correction for multiple comparisons. Additionally, independent samples t-tests were conducted to examine group differences in RAI at each time point separately, with p-values adjusted using the Bonferroni method.

To examine whether autonomous motivation predicted program attendance, we conducted multiple linear regression analyses with attendance frequency (number of weeks attended) as the dependent variable. Separate models were tested for t1 and t2 attendance. For the t1 attendance model, independent variables included baseline (t0) RAI scores, group membership, age, and gender. For the t2 attendance model, independent variables included t1 RAI scores, group membership, age, and gender. Standardized regression coefficients (β) and R^2 values were reported to indicate effect sizes.

Results

Descriptive Analyses

Sample Characteristics

Baseline characteristics of the analytical sample are presented in Table 1.

Table 1
Baseline Characteristics by Group

N	*Overall*	*Digitally Supported*	*Conventional*
	163	**96**	**67**
Male	51 (31%)	33 (34%)	18 (27%)
Female	112 (69%)	63 (66%)	49 (73%)
Age	51.69 (7.96)	51.53 (7.90)	51.93 (8.11)
Note. N (%); mean (SD)			

The overall sample had a mean age of 51.69 years (SD = 7.96) and was predominantly female (69%). The digitally supported group (M = 51.53, SD = 7.90) and conventional group (M = 51.93, SD = 8.11) did not differ significantly in age ($t(139.8) = 0.31$, $p = .758$). Gender distribution was also comparable between groups, with 66% female participants in the digitally supported group and 73% in the conventional group ($\chi^2(1, N = 163) = 0.72$, $p = .398$). Baseline comparison of motivational composition revealed no significant differences between groups on the Relative Autonomy Index ($t(113) = 0.31$, $p = .756$), indicating equivalence in initial motivation quality at study entry.

Descriptive Statistics

Descriptive statistics for the Relative Autonomy Index across the three measurement points in the analytical sample (N = 163) are presented in Table 2. At baseline (t0), both groups reported similar mean RAI scores, with 13.37 (SD = 2.63) in the digitally supported group and 13.21 (SD = 3.62) in the

conventional group, for an overall mean of 13.30 (SD = 3.07).

Over the 24-week intervention period, the two groups showed divergent

Table 2
Relative Autonomy Index (RAI) by Group and Time Point

Group	*N*	*Baseline (t0)*	*12 Weeks (t1)*	*24 Weeks (t2)*
Digitally Supported	96	13.37 (2.63)	12.13 (3.57)	11.82 (3.77)
Conventional	67	13.21 (3.62)	13.77 (2.87)	12.68 (4.69)
Overall	163	13.30 (3.07)	12.81 (3.39)	12.17 (4.18)
Note. Mean (SD)				

patterns. Overall, mean RAI across both groups decreased from 13.30 at baseline to 12.81 (SD = 3.39) at t1 and 12.17 (SD = 4.18) at t2.

Descriptive statistics for program attendance (weeks attended) are presented in Table 3. At the 12-week assessment (t1), participants in the digitally supported group reported attending an average of 10.27 weeks (SD = 3.56), while those in the conventional group reported 7.92 weeks (SD = 4.88), with an overall mean of 9.33 weeks (SD = 4.29). A Welch's t-test indicated that this difference between groups was statistically significant (t(107.00) = 3.31, p = .001). By the end of the 24-week intervention (t2), cumulative attendance had increased to 18.75 weeks (SD = 7.13) in the digitally supported group and 13.56 weeks (SD = 7.30) in the conventional group, with an overall mean of 16.61 weeks (SD = 7.62). The difference between groups remained statistically significant at t2 (t(127.00) = 4.30, p < .001).

Table 3
Program Attendance by Week

Group	***N***	***12 Weeks (t1)***	***24 Weeks (t2)***
Digitally Supported	96	10.27 (3.56)	18.75 (7.13)
Conventional	67	7.92 (4.88)	13.56 (7.30)
Overall	163	9.33 (4.29)	16.61 (7.62)
Note. Mean (SD)			

The digitally supported group thus showed higher attendance frequency at both measurement points, with mean differences of approximately 2.4 weeks at t1 and 5.2 weeks at t2, though substantial variability existed within both groups.

Analyses of Variance

Motivational changes over time were examined using a repeated measures ANOVA with time (t0, t1, t2) as the within-subject factor and group (digitally supported vs. conventional) as the between-subject factor. Mauchly’s test did not indicate a violation of the sphericity assumption (W = 0.969, p = .083), and no correction was applied. Visual inspection of Q–Q plots suggested approximately normal distributions of RAI scores across groups and time points, with only minor deviations in the tails. Levene’s test indicated heterogeneity of variances at baseline (F(1, 161) = 5.82, p = .017), but homogeneity at t1 (F(1, 161) = 1.32, p = .252) and t2 (F(1, 161) = 0.911, p = .341). Motivational developments for both groups over time are depicted in Fig. 1. The repeated measures ANOVA (Table 4) showed a significant main effect of time (F(2, 322) = 6.64, p = .001, η^2 = .040), indicating an overall decrease in autonomous motivation across the 24-week period. There was no significant main effect of group (F(1, 161) = 2.93, p = .089, η^2 = .018), suggesting no overall difference in motivational levels between the digitally supported and conventional programs.

Table 4
ANOVA Results for Relative Autonomy Index

Effect	***df***	***MS***	***F***	***p***	***η²***
Within Subject Effects					
Time	2	44.2	6.641	0.001	0.040
Group x Time	2	32.1	4.825	0.009	0.029
Residual	322	6.7			
Between Subject Effects					
Group	1	71.6	2.928	0.089	0.018
Residual	161	24.5			

Note. Type 3 Sums of Squares. *df = Degrees of Freedom; MS = Mean Square; F = F-ratio; p = p-value; η² = Partial Eta-Squared*

However, the time-group interaction was significant (F(2, 322) = 4.83, p = .009, η² = .029), indicating that the two groups differed in their motivational trajectories over time. In the digitally supported group, RAI declined progressively from baseline to 12.13 (SD = 3.57) at 12 weeks (t1) and further to 11.82 (SD = 3.77) at 24 weeks (t2). In contrast, the conventional group showed an initial increase to 13.77 (SD = 2.87) at t1, followed by a decline to 12.68 (SD = 4.69) at t2.

Analyses of Variance with Age and Gender

To account for potential confounding effects of age and gender, a repeated measures ANCOVA was conducted with age as a covariate and gender as an additional between-subject factor. The results (Table 5) showed a significant time-group interaction (F(2, 316) = 4.51, p = .012, η² = .028), whereas all other main effects and interaction terms were non-significant.

Table 5
ANCOVA Results for Relative Autonomy Index

Effect	*df*	*MS*	*F*	*p*	*η²*
Within Subject Effects					
Time	2	38.5	2.881	0.058	0.018
Group x Time	2	60.3	4.509	0.012	0.028
Age x Time	2	23.5	1.756	0.174	0.011
Gender x Time	2	2.8	0.211	0.810	0.001
Group x Gender x Time	2	3.6	0.267	0.766	0.002
Residual	316	6.7			
Between Subject Effects					
Age	1	33.6	1.362	0.245	0.009
Group	1	37.6	1.525	0.219	0.010
Gender	1	2.1	0.087	0.768	< 0.001
Group x Gender	1	11.7	0.473	0.492	0.003
Residual	158	24.6			

Note. Type 3 Sums of Squares. *df = Degrees of Freedom; MS = Mean Square; F = F-ratio; p = p-value; η² = Partial Eta-Squared*

The previously significant main effect of time became non-significant after including age and gender in the model. These findings indicate that group-specific motivational trajectories over time persist even when adjusting for age and gender.

Post-hoc Analyses

Pairwise within-group comparisons between time points revealed a significant decline in RAI from baseline to mid-intervention for the digitally supported group (t(95) = 3.09, p = .008) and from baseline to post-intervention (t(95) = 4.07, p < .001), with no further significant change from t1 to t2 (t(95) = 0.90, p = 1.00). For the conventional group, there was a significant decrease in RAI from t1 to t2 (t(66) = 2.65, p = .030), whereas changes between baseline and mid-intervention (t(66) = -1.48, p = .426) and between baseline and post-intervention (t(66) = 1.02, p = .927) were not significant. Pairwise between-group comparisons at each time point showed a significant difference at t1 (t(158) = -3.24, p = .004), with the conventional group exhibiting a higher mean RAI score. Comparisons at baseline (t(113) = 0.31, p = .756) and post-intervention (t(122) = -1.24, p = .651) were not significant.

Regression Analyses

The second aim of this study was to examine whether autonomous motivation predicts program attendance. In a first multiple linear regression (Table 6), attendance at t1 served as the outcome, with baseline RAI score, group, age, and gender as predictors. The overall model was statistically significant ($F(4, 154) = 4.24$, $p = .003$, $R^2 = .099$).

Table 6
Linear Regression: Predictors of Program Attendance at 12 Weeks

Predictor	***B [95% CI]***	***SE***	***β***	***t***	***p***
(Intercept)	8.776 [3.604, 13.948]	2.618	-	3.352	0.001
RAI (t0)	0.037 [-0.175, 0.249]	0.107	0.026	0.345	0.731
Group_Conventional	-2.273 [-3.593, -0.952]	0.668	-0.261	-3.400	0.001
Age	0.037 [-0.045, 0.118]	0.041	0.068	0.882	0.379
Gender_Female	-1.333 [-2.727, 0.062]	0.706	-0.145	-1.888	0.061
Note. R2 = .099 (N = 159, p = .003)					

Group assignment emerged as the only significant predictor (B = -2.27, SE = 0.67, $p < .001$), with the conventional group reporting 2.27 fewer active weeks than the digitally supported group. Baseline autonomous motivation, age, and gender were not significant predictors.

The analysis for RAI at t1 predicting attendance at t2 revealed a similar pattern (Table 7). The overall model again showed significance ($F(4, 143) = 6.91$, $p < .001$, $R^2 = .162$).

Group assignment remained the strongest predictor (B = -5.35, SE = 1.22, $p < .001$), with the conventional group reporting 5.35 fewer active weeks than the digitally supported group.

Table 7. Linear Regression: Predictors of Program Attendance at 24 Weeks

Predictor	**B [95% CI]**	**SE**	**β**	**t**	**p**
(Intercept)	12.016 [3.414, 20.618]	4.352	-	2.761	0.007
RAI (t1)	0.195 [-0.148, 0.538]	0.173	0.089	1.125	0.262
Group_Conventional	-5.347 [-7.765, -2.929]	1.223	-0.346	-4.371	0.000
Age	0.119 [-0.023, 0.262]	0.072	0.127	1.651	0.101
Gender_Female	-2.633 [-5.174, -0.093]	1.285	-0.157	-2.049	0.042
Note. R2 =. 0.162 (N = 159, p = < .001)					

Gender also emerged as a significant predictor (B = -2.63, SE = 1.29, $p = .042$), with women reporting an average of 2.6 fewer active weeks than men. Autonomous motivation at t1 and age were not significant

predictors.

Discussion

This study examined whether motivational composition develops differently in digitally supported compared with conventional prevention programs and whether autonomous motivation predicts program attendance over time. The results show diverging motivational trajectories over time between the digitally supported and conventional prevention groups. Significant differences in motivational quality emerged at the mid-intervention measurement. From a SDT perspective, such differences are compatible with the assumption that intervention environments can differentially support or frustrate the basic psychological needs autonomy, competence, and relatedness, which in turn shape motivational quality [28]. Digital formats may enhance autonomy by offering participants flexibility in timing and location of engagement, and may support competence through personalized feedback, progress tracking, and tailored content [12, 18], yet they may also pose challenges for competence when guidance is less immediate or when technical difficulties occur [29]. In addition, the reduced face-to-face contact may limit opportunities for relatedness, a need that has been linked to sustained engagement in health behavior [20, 22].

The results of this study emphasize the potential role of relatedness in health behavior. While the digitally supported group experienced a steady decline in motivational quality over the observation period, the conventional group showed an initial increase followed by a decrease between mid-intervention and post-intervention. The second observation period in the conventional group coincides with the self-initiative phase of the prevention program, during which participants no longer attended regular in-person sessions. The absence of face-to-face contact during this phase may therefore serve as an explanation for the decrease in motivational quality observed in both delivery formats, potentially overriding positive effects of increased autonomy.

However, the expected relationship between more autonomous forms of motivation and program attendance could not be demonstrated in the present sample. While the conventional group showed higher levels of autonomous motivation, especially at the mid-intervention assessment, the digitally supported group consistently exhibited more active weeks during the prevention program. The lack of predictive power of autonomous motivation could be explained by several mechanisms. Structural constraints may favor digitally supported programs and therefore override motivational mechanisms. Digital prevention formats offer better integration into participants' daily lives and can overcome temporal and spatial constraints that conventional formats face. Additionally, more autonomous forms of motivation are believed to especially influence long-term adherence, whereas short-term behavior change can also be initiated by more external forms of motivation. The present study did not observe health behavior after the end of the intervention period. Therefore, no conclusions can be drawn about long-term behavioral effects of autonomous motivation on sustained engagement beyond program completion. However, the lack of predictive power in this study could also suggest that the validity of SDT may be context-dependent. While adherence to leisure-time physical activity has been consistently

explained by autonomous motivation [30, 31], mechanisms underlying participation in prevention programs may differ. Health maintenance could be viewed as a somewhat burdensome duty and not as an activity that is driven by intrinsic motivation.

This study underlines the potential of digital interventions to make health measures more accessible and overcome temporal and spatial barriers that people face. Therefore, they demonstrate the capacity of positively influencing health behavior. However, from a motivational psychology perspective, the design of such digital health measures plays a crucial role in their long-term effectiveness. In order for digital prevention measures to affect health behaviour beyond the intervention period, intrinsic motivation for health behavior such as regular physical activity must be targeted specifically. Alberts et al. [32] identify two approaches to designing behavior change technologies. An engagement-focused approach to target intrinsic motivation through the satisfaction of basic psychological needs and an internalization-focused approach to shift already existing but externally motivated behavior toward more autonomous motivated behavior. Given the previously identified key role of relatedness, the engagement-focused approach could target social interaction by encouraging networking between participants and certain elements of gamification such as badges, individual points and leaderboards which have shown to improve intrinsic motivation in academic settings [33]. More individualized tailoring of interventons and providing more choices in the intervention courses could further enhance feelings of autonomy [32]. Feelings of competence could be targeted by enabling difficulty adjustment and improving task and self-knowledge which includes tracking one's progress [32].

However, as sustained engagement with the technology - especially in time-limited inteventions - should not be the primary focus, the internalization-focused approach could offer valuable insights in how to foster long-term behavior change. Gerstenberg et al. [34] reflect on a process on how SDT's Organismic Integration Theory can inform the design of health technologies by gradually shifting externally motivated behavior toward self-determined behavior. A central step towards this integration process is the assessment of the user's predominant regulatory type for health behavior. Building upon the identified type, the appropriate technology should target the next step in the internalization journey. While implementing the full process on a large-scale basis is challenging, some aspects could be crucial such as looking beyond the mere satisfaction of psychological needs and focusing on value alignment, meaningful self-reflection and the personal relevance of the behavior [34]. This approach requires the assessment of motivation via questionnaires that capture various regalution types such as the BREQ-2 [24] used in the present study.

Further strengths of this study include the longitudinal design that captures motivational trajectories over time in a real-world prevention setting, rather than relying solely on baseline or endpoint assessments. The study was pre-registered and adhered closely to an analysis plan developed before examining the data, reducing researcher degrees of freedom.

However, several limitations must be acknowledged. Since both groups were recruited from separate clinics - the digitally supported group exclusively from Knappschafts-Klinik Borkum and the conventional

group from three different facilities - program format effects cannot be disentangled from contextual or clinic-specific factors. This confounding of format and setting limits causal inference about digital delivery per se. Additionally, randomization could not be performed due to ethical considerations, introducing potential selection bias. Over the course of the program, substantial attrition occurred (from N = 245 at baseline to N = 163 with complete data), leading to missing data that may bias the results if dropout was systematically related to motivation or program satisfaction. Regarding measurement instruments, Cronbach's alphas for some BREQ-2 subscales exhibited relatively low values in the present sample, potentially introducing measurement error that could attenuate observed relationships. Furthermore, attendance was assessed via self-report, which is vulnerable to recall bias and social desirability effects, rather than through objective tracking methods such as digital platform analytics or clinic attendance records.

An additional limitation concerns data collection during the COVID-19 pandemic. The availability of face-to-face courses was likely affected by pandemic-related restrictions, potentially favoring digital delivery formats due to circumstances rather than inherent program characteristics. Moreover, the role of social relatedness in health behavior may be overemphasized in these findings due to the heightened social isolation that pandemic policies created, which could have amplified participants' need for social connection beyond what would be observed under normal circumstances.

While digital prevention programs are effective in improving health-related outcomes [16] and demonstrate higher attendance rates compared to conventional counterparts, motivational quality must be considered when designing digital interventions. Given the positive evidence for SDT-informed health interventions [23, 35, 36], future prevention programs should explicitly address basic psychological need satisfaction - particularly relatedness and competence in digital contexts - to further improve long-term effectiveness and sustained behavior change beyond program completion.

Conclusions

Despite achieving higher participation rates, digitally supported prevention programs were associated with continuous decline in autonomous motivation compared to conventional formats, which showed initial motivational gains before declining during phases with reduced social contact. Given that autonomous motivation is theorized as a prerequisite for sustained behavior change, these findings underscore the critical need to explicitly design digital health platforms to support basic psychological needs - particularly relatedness and competence alongside the autonomy that digital formats naturally afford - to ensure that increased reach translates into long-term effectiveness.

Declarations

Ethics Approval and Consent to Participate

The present study was carried out in compliance with the principles outlined in the Declaration of Helsinki. Participants provided informed consent on a voluntary basis and could withdraw from the study at any time without providing a reason, and without experiencing any negative consequences in terms of their subsequent medical care. Participants' consent was recorded via their signature on the informed consent forms. The Ethics Committee of the Karlsruhe Institute of Technology granted approval for the study on March 20, 2019, including all participants, conditions, and health centers involved in the project.

Consent for Publication

Not Applicable.

Competing Interests

The authors declare that they have no competing interests.

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Author Contribution

BB contributed to the data analysis and writing of the original draft. DS contributed to the conceptualization, planning and acquisition of funding. DJ contributed to the conceptualization, planning, coordination, supervision of the writing and revision of the final manuscript. All authors read and approved the final manuscript.

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

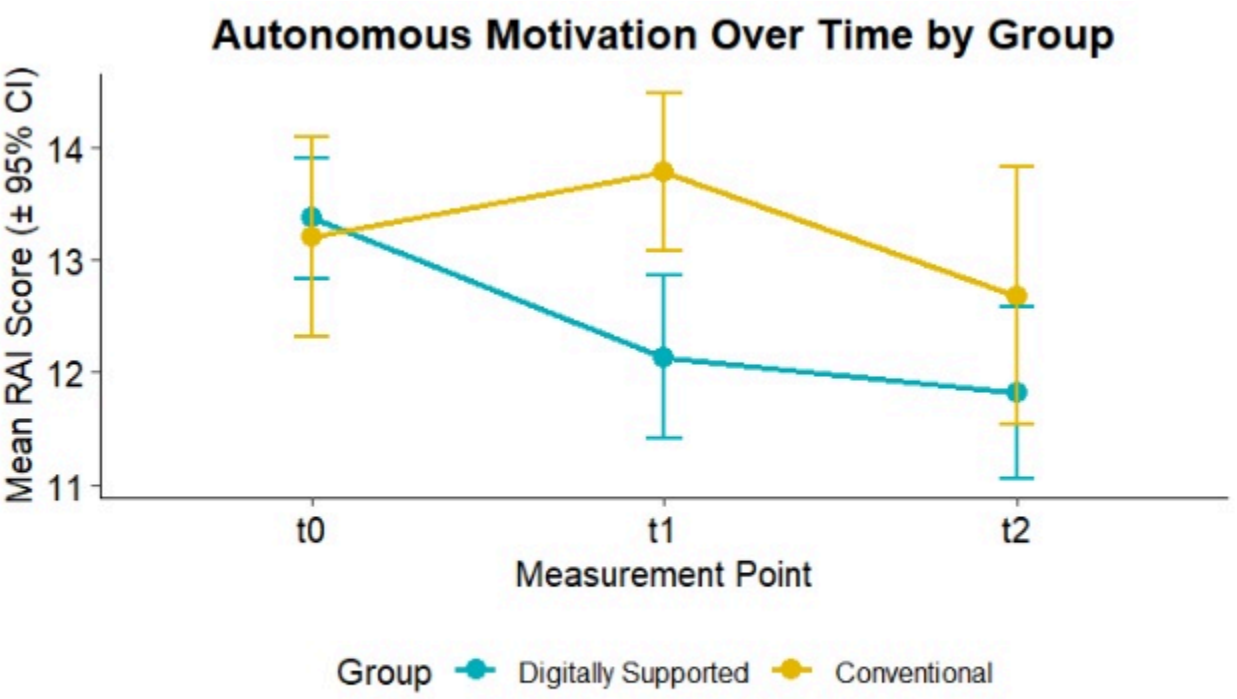


Figure 1

Autonomous Motivation over Time by Group