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Less smartphone and more physical activity for a better work satisfaction, motivation, work-life balance, and mental health: An experimental intervention study

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ABSTRACT

Employees' work satisfaction and mental health are crucial for an organization's productivity. The current experimental study on employees ($N_{total} = 278$) from different professional sectors and workplaces in Germany investigated how to improve both by changes of daily non-work-related smartphone use time and physical activity time. For one week, the smartphone group ($N = 73$) reduced its daily smartphone use by one hour, the physical activity group ($N = 69$) increased its daily physical activity by 30 minutes, the combination group ($N = 72$) followed both interventions, the control group ($N = 64$) did not change its behavior. Online surveys assessed work-related and mental health-related variables at three measurement time points (baseline; post-intervention; two-week follow-up). The reduction of smartphone use time and the combination of both interventions increased work satisfaction, work motivation, work-life balance, and positive mental health significantly; experience of work overload and problematic smartphone use significantly decreased. All interventions decreased depressive symptoms and enhanced sense of control significantly. Following the present findings, a conscious and controlled reduction of non-work-related smartphone use time and its combination with more physical activity could improve employees' work satisfaction and mental health in the organizational context either as an addition to established training programs or as a separate time- and cost-efficient low threshold program.

1. Introduction

On average, we spend about 230 days per year at our workplace in countries with a 5-day week, and about 280 days in countries with a 6-day week without considering country and federal state specific holidays (SteuerGo, 2024). Considering that those are between 63 % and 77 % days of a year, the close positive mutual relationship between work satisfaction (i.e., satisfaction experienced within the context of work) and mental health does not seem surprising (Capone & Petrillo, 2020). A low work satisfaction can negatively impact employees' mental health and a low level of mental health can contribute to low work satisfaction (e.g., Rössler, 2012). Notably, both are of great importance for employees' performance, organizational positive commitment and productivity (Pudyaningsih et al., 2020).

1.1. Work and mental health

Against this background many organizations invest high sums for external business coaches to improve employees' work satisfaction and mental health (Marrone et al., 2022; Wang et al., 2021). In short-term or longer-term training programs, the coaches often focus on factors that available literature revealed to influence both issues (Ocen et al., 2017; Tabvuma et al., 2015). For example, they aim at enhancing employees' work motivation (Pancasila et al., 2020) that has been defined as “a set of energetic forces that originate both within as well as beyond an individual's being, to initiate work-related behavior and to determinate its form, direction, intensity, and duration” (Latham & Pinder, 2005, p. 486; Pinder, 1998, p. 11); reducing employees' experience of work overload that is the feeling of being overwhelmed and exhausted by tasks and deadlines at work as well as by stressful confrontations with superiors and other employees (Giel & Breuer, 2021; Gu et al., 2020; Lu

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et al., 2019); and fostering employees' work-life balance (Gragnano et al., 2020; Kotera et al., 2021). Notably, the available literature demonstrates various definitions of the term “work-life balance” (Kalliath & Brough, 2008). In the present study, we fellow the definition provided by Clark (2000, p. 751) who described work-life balance as “satisfaction and good functioning at work and home, with a minimum of role conflict”.

Considering mental health, the trainings often follow the dual-factor models. The models explain mental health by two interrelated but separate dimensions (positive and negative; e.g., Keyes et al., 2002). Accordingly, a complete mentally healthy person has a low level on the negative dimension and a high level on the positive dimension (Suldo & Shaffer, 2008). Therefore, the trainings aim at reducing the negative dimension of mental health and at enhancing the positive one (Corrie & Parsons, 2021; Grover & Furnham, 2016). Depressive symptoms are often considered as a representative of the negative dimension (Capone & Petrillo, 2020). They belong to the main reasons for employees' decreased quality of life, productivity loss, absence from workplace, morbidity, and mortality (Cao et al., 2022; Kidger et al., 2016; Summers et al., 2020; World Health Organization, 2023). A reduction of depressive symptoms at an early stage belongs to important aims of the trainings (Martin & Fisher, 2014; Shann et al., 2019). Positive mental health (PMH) – defined as psychological, social and emotional well-being (Lukat et al., 2016) – is often considered as an operationalization of the positive dimension (Trompetter et al., 2017). Persons with a high PMH level are characterized by self-efficacy, resilience, and optimism (Lamers et al., 2015). In a stressful overwhelming situation, they typically tend to functional coping strategies that reduce the negative circumstances that caused the situation (Truskauskaite-Kuneviciene et al., 2020). Therefore, an enhancement of PMH is a frequent aim of the trainings (Bora et al., 2010; Deroncele-Acosta et al., 2024; Grant, 2020; Lee et al., 2020).

Furthermore, the trainings often focus on an increase of employees' sense of control (Liu et al., 2018). Sense of control is a basic need of human beings (Southwick & Southwick, 2018). Frequent experiences of control loss in important areas of daily life – such as the workplace – can result in dysfunctional coping strategies to gain the control back (Skaff, 2007). The strategies can include destructive activities such as aggressive behavior that negatively impact the organizational climate and productivity (Clark, 2002), as well as self-harming behavior such as enhanced consume of alcohol or other risky activities (Hamonniere et al., 2020; Peacock & Bruno, 2015). In contrast, a high level of sense of control is typically accompanied by functional coping strategies (Seligman et al., 2005), high PMH and low depressive symptoms (Precht et al., 2021).

While some training programs successfully achieve the intended effects of improving work satisfaction and mental health, others prove to be less effective (e.g., Huang, 2020; Jehanzeb et al., 2015; Ocen et al., 2017). Regardless of their effectiveness, most training programs share common factors, such as being often time- and cost-intensive and conduced in-person, which means that the employees are absent from the workplace during that time (Grover & Furnham, 2016). This poses a challenge to the employers who, on the one hand, have to keep up with the need for speed in performances in the age of digitalization and, therefore, require each employee at the workplace (Polozhentseva et al., 2019), and on the other hand, want to support their employees by time-intensive training programs. Some organizations cannot bear the training costs and tolerate the employees' absence during the training without significant economic losses.

Against this background, relatively short and cost-efficient interventions that organizations across a wide budget range can afford are highly desirable. In the best case, the interventions can be integrated in employees' everyday lives to improve work-related and mental health-related outcomes at once. Recent research revealed promising interventions that could comply to the requirements (e.g., Hoong, 2021; Hughes & Burke, 2018; Precht et al., 2023). Notably, all of them focused on changing one's pattern of daily non-work-related smartphone use, either alone or in combination with other modifications to everyday live.

1.2. (Problematic) smartphone use

In the year 2023, about 6.71 billion people around the globe owned a smartphone (Turner, 2024) and spent on average 3 h and 15 min on its use daily (Howarth, 2024). For some people smartphone use is the first thing that they do upon awaking and the last thing before falling asleep (Hughes & Burke, 2018). Through numerous offline and online applications, smartphones are used for various issues in everyday life. They contribute to our permanent availability, provide us with access to social media, e-mails, news, videos, games, web mapping services and much more (Elhai, McKay, et al., 2021). At work and leisure, smartphones can make our life easier and speed up various processes (Liebherr et al., 2020).

Despite the obvious benefits of smartphone use, available literature emphasized its risks for mental and physical health, as well as work and academic performance (Amez & Baert, 2020; Elhai et al., 2019b; Ellahi et al., 2021; Yang et al., 2020). Some people engage in excessive smartphone use to escape overwhelming problems (Elhai et al., 2020; Randjelovic et al., 2021). Frequently, they turn to social media platforms such as TikTok, Instagram and Facebook as well as instant messenger services like WhatsApp, Signal and Telegram for active social interaction and self-presentation, or they passively follow content created by others (Rozgonjuk et al., 2021). Both activities can contribute to mood improvement and relief in the short-term (Giordano et al., 2021). However, as explained by the Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behavior (Brand et al., 2019), the prolonged time spent on smartphone use and the positive experiences can enhance the risk of developing a pathological emotional bond to the smartphone (Park et al., 2021). This bond is characterized by an obsessive need to permanently continue the use (Brailovskaia & Margraf, 2023b). In situations of non-use, symptoms of mental and physical withdrawal can be experienced (Elhai, McKay, et al., 2021).

A consensus about a standardized term for this phenomenon is lacking. Earlier research often termed it as smartphone addiction, problematic, addictive, or compulsive smartphone use (Elhai et al., 2019a). Following available recommendations (Ting & Chen, 2020), we will use the term “problematic smartphone use (PSU)” in the present study. PSU has been defined by characteristics such as salience, tolerance, mood modification, lack of control, relapse, withdrawal symptoms and conflicts (Sohn et al., 2019). So far, it has not been recognized as a formal psychiatric disorder in the International Classification of Diseases (ICD-11; World Health Organization, 2018) and the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). Furthermore, some researchers emphasized that excessive digital technology and media use should not be over-pathologized (Carbonell & Panova, 2017; Orben et al., 2020). However, it cannot be denied that potential negative effects of PSU in particular and of time spent on smartphone use in general have been described by available studies (see e.g., Busch & McCarthy, 2021).

1.3. Empirical evidence on correlates of (problematic) smartphone use including physical activity

Cross-sectional research indicated a close positive association of PSU with depressive symptoms, repetitive negative thinking (a close correlate of depressive symptoms; Spinhoven et al., 2018), anxiety symptoms, and fear of missing out (Augner et al., 2023; Brailovskaia et al., 2021; Elhai et al., 2020; Elhai, McKay, et al., 2021; Elhai, Yang, & Montag, 2021; Wang et al., 2022); in contrast, PSU was negatively associated with life satisfaction, sense of control and empathy (Brailovskaia et al., 2021; Lachmann et al., 2018; Yang et al., 2019). Smartphone use time was positively related with sleep problems, attention deficit hyperactivity disorder, symptoms of depression, anxiety and stress (Brodersen et al., 2022; Heo et al., 2017; Li et al., 2015; Ng et al., 2020; Stanković et al., 2021; Studer et al., 2022). Similar to PSU, there was a negative relationship between smartphone use time and life satisfaction (Studer et al., 2022). Moreover, time spent on smartphone use was positively linked to a low level of physical activity and fitness, as well as an enhanced risk for obesity (Fennell et al., 2021; Ikeda et al., 2024; Kenney & Gortmaker, 2017; Yoo et al., 2020). Considering its positive association with muscle fatigue and pain in the neck-shoulder region, available research emphasized that the unnatural forward-leaning head posture during smartphone use could negatively impact physical health (Derakhshanrad et al., 2021; Neupane et al., 2017; Xie et al., 2016). Furthermore, research that used neuroimaging methods such as the functional magnetic resonance imaging (fMRI) revealed that excessive smartphone use is positively associated with changes in brain functions and structure (e.g., lower volume in the superior cerebellar peduncle, lower gray matter volume in some brain regions such as the striatum, higher functional connectivity between the midcingulate cortex and Nucleus Accumbens) (for overview see Montag & Becker, 2023). In addition, time on non-work-related smartphone use at the workplace was negatively associated with employees' cognitive engagement in the task performed and the overall daily performance (Du et al., 2022; Duke & Montag, 2017).

Longitudinal research described that both smartphone use time and PSU were positively associated with feelings of loneliness, symptoms of depression, anxiety, and stress up to three years later (Dissing et al., 2022; Lapierre et al., 2019; Zhang et al., 2020). Furthermore, smartphone use in general and bedtime smartphone use in particular were positively linked to a reduced academic performance up to two years later (Amez et al., 2023; Lin & Zhou, 2022). Our systematic literature search in the databases Web of Science, PubMed, and PsycInfo as a preparation step for the present study revealed a lack of longitudinal research on the relationship between non-work-related smartphone use and work-related outcomes.

Notably, only experimental research can provide true conclusions on causality (Kraemer et al., 1997). In the context of smartphone use, experimental research showed that controlled and conscious changes of smartphone use (time) can significantly contribute to various areas of life (see e.g., Brailovskaia, Delveaux, et al., 2023; Olson et al., 2023). The changes ranged from relatively soft instructions, such as adjustments to smartphone settings, to more stringent requirements, such as a complete waiver of smartphone use. For example, Olson et al. (2023) showed that conscious changes to smartphone settings (e.g., changing the display to grayscale, keeping the phone on silent) over two weeks reduced smartphone use time, PSU, depressive symptoms, and they improved sleep quality up to six weeks later. Hoong (2021) asked study participants to set self-selected time limits on their daily smartphone use for a 1-week period. This intervention resulted in a reduction of PSU up to one month later. A 1-week abstinence from smartphone use in the bedroom resulted in a decrease of PSU and an increase of quality of life and subjective happiness (Hughes & Burke, 2018). A 10-day abstinence from smartphone use contributed to a reduction of PSU characteristics such as withdrawal symptoms (Zinn & Rademacher, 2019). A complete waiving as well as a reduction of daily time spent on non-work-related smartphone use by one hour for one week resulted in a decrease of PSU, depressive and anxiety symptoms; life satisfaction and physical activity increased (Brailovskaia, Delveaux, et al., 2023). Hereby, the reduction showed stronger and more stable effects than the waiving up to four months later. This provides evidence that a reduction of use time could be sufficient and a complete waiver – which is less realistic to maintain over a longer period than a reduction – is not urgently required.

Smartphone use provides a person with positive experiences and its reduction requires a kind of "compensation" for the experiences (Brailovskaia & Margraf, 2023b). Against this background, participants in a further intervention study were asked not only to consciously reduce their daily smartphone use time by one hour, but also to enhance their physical activity (e.g., jogging, cycling, swimming) – that contributes to positive emotions if carried out regularly (Richards et al., 2015) – by at least 30 min a day over two weeks (Precht et al., 2023). The authors followed recommendation of the World Health Organization (2020) to engage for about 150 min in moderate physical activity throughout the week or at least 30 min per day as an important protective factor of physical and mental health. Available literature emphasized the positive effects of moderate physical activity on mental health like a decrease of depressive and anxiety symptoms, as well as an improvement of PMH, life satisfaction and happiness (Brailovskaia et al., 2022; Eek et al., 2021; Mücke et al., 2018). Regular engagement in physical activity enhances one's sense of control and reduces stress symptoms (Precht et al., 2021; Wunsch et al., 2017). The combined intervention of Precht et al. (2023) showed a decrease of PSU and depressive symptoms, and an increase of PMH. Results were stable up to three months after the intervention. Notably, the increase of physical activity only showed less promising and stable findings than the combination (Precht et al., 2023).

Thus, we can conclude that especially a conscious reduction of non-work-related smartphone use time contributes to mental health-related outcomes. It is a low threshold cost-efficient intervention that can be implemented in one's everyday life. Its positive effects can be observed already within one or two weeks, and they remain stable over several months.

Following recent findings (Brailovskaia, Becherer, et al., 2023; Whelan & Turel, 2023), it is not necessary to focus hereby specifically on a reduction of use time during working hours. Rather the focus should be on a general conscious reduction of smartphone use time in everyday life. Whelan and Turel (2023) reported that work-life conflicts decreased in a company that revoked a ban on non-work-related smartphone use at the workplace, while the work performance remained unchanged. Furthermore, Brailovskaia, Becherer, et al. (2023) showed in an experimental study that a conscious 1-week reduction of social media use time for 30 min significantly improved not only employees' mental health-related outcomes but also work-related outcomes like work satisfaction and experience of work overload. Participants were free to choose when during the day to reduce their use time.

1.4. The present study

Against the presented empirical background, reducing employees' non-work-related smartphone use time could be a promising step in the work context. However, there is a lack of research on this issue so far. Available literature on changes of smartphone use habits worked mostly with young students and did not include work-related outcomes (e.g., Brailovskaia, Delveaux, et al., 2023; Hughes & Burke, 2018). Thus, we can only speculate whether the encouraging findings can be applied to the context of working professionals.

In the present study, we aimed to close this research gap and to investigate how a controlled and conscious experimental reduction of daily non-work-related smartphone time of employees from different professional sectors could influence work-related and mental health-related outcomes. Moreover, following the idea of Precht et al. (2023) that people who reduce smartphone use time need an alternative activity that can also evoke positive emotions, we aimed to assess whether a controlled and conscious increase of physical activity time could enhance the potential effects of smartphone use time reduction. Notably, earlier research showed that leisure-time physical activity was negatively linked to employees' experience of work overload (Toker & Biron, 2012); its link to work satisfaction was positive (Arslan et al., 2019; Dallmeyer et al., 2023).

Thus, we tested overall three interventions: reduction of smartphone use time, increase of physical activity time, combination of both interventions. In the selection of investigated variables, we followed training programs in organizations that often focus on work satisfaction, mental health and factors that could influence both (Marrone et al., 2022; Wang et al., 2021). Therefore, we included work satisfaction, work motivation, work overload and work-life balance as work-related variables (e.g., Gragnano et al., 2020; Kotera et al., 2021); depressive symptoms and PMH as mental health-related variables, as well as sense of control and PSU (e.g., Corrie & Parsons, 2021; Grover & Furnham, 2016).

1.4.1. Hypotheses and research question

Against the presented empirical and theoretical framework, we hypothesized that all three interventions are accompanied by an increase of work satisfaction (Hypothesis 1a), work motivation (Hypothesis 1b), and work-life balance (Hypothesis 1c), as well as a decrease of experienced work overload (Hypothesis 1d). Considering mental health, we hypothesized that the three interventions are accompanied by a decrease of depressive symptoms (Hypothesis 2a) and PSU (Hypothesis 2b), as well as by an increase of PMH (Hypothesis 2c) and sense of control (Hypothesis 2d). Hereby, we were interested in whether the hypothesized effects can be found directly after the intervention period and two weeks later. And to avoid speculations, we formulated an exploratory research question: How do the effects of the three interventions differ? (Research Question).

Our findings could provide experimental evidence on the association between smartphone use and physical activity, on the one hand, and work-related and mental health-related outcomes, on the other hand. Furthermore, they could reveal information on potential time- and cost-efficient interventions that can be integrated in employees' everyday lives to improve work-related and mental health-related outcomes and thus contribute to the organizational productivity. If successful, the interventions could be used separately or in addition to more complex training programs.

2. Methods and materials

2.1. Procedure

We designed the present study as a randomized controlled trial. It included three experimental groups – smartphone group, physical activity group, combination group – and a control group, as well as three measurement time points. Following available experimental literature on changes of media use (e.g., Precht et al., 2023), participants of the smartphone group reduced the daily non-work-related smartphone use time by 60 min (= first intervention), participants of the physical activity group increased the daily physical activity time by 30 min (= second intervention), participants of the combination group were involved in both interventions simultaneously (= third intervention), and participants of the control group did not receive specific instructions on a behavioral change. The interventions were set for a period of seven days (= experimental manipulation/intervention period). We collected data by three measurements via online surveys in German language (survey platform *www.unipark.de*). To assess a baseline of the variables, the first measurement took place on the day prior to the beginning of the intervention period (baseline, Day 0); the second measurement was set the next day after the intervention period (post-intervention, Day 8); the third measurement took place two weeks after the post-intervention measurement (two-week follow-up, Day 22). This procedure enabled us to investigate effects of the experimental manipulations directly after the intervention period and up to two weeks later. Participants received all instructions and the online links to the surveys via e-mail. They were free to decide when to integrate the intervention during the daily routine. At the beginning of each survey, they generated an individual participant code. After the data collection, the three data sets of each participant were matched by the code and the code was deleted to anonymize the data.

2.2. Participants

Data collection took place from May 2022 to July 2023. Participants were recruited by invitations displayed at public places in Germany and on social media (LinkedIn, X, Facebook). The invitations included the heading "Smartphone Use, Physical Activity and Work" followed by an explanation of the study's aim ("We are investigating the relationship between smartphone use, physical activity, work-related and mental health-related factors. Based on the intervention condition you might be asked to change the time that you spend daily on smartphone use and/or on physical activity. If you would like to do this, you are welcome to participate in our investigation."), participation requirements, the contact e-mail address of the principal investigators, and an explanation of the individual information that should be included in the e-mail to the principal investigators. People interested in participation contacted the principal investigators by e-mail. The e-mail should include the mean time (in minutes) that they spend daily on non-work-related smartphone use and their mean daily physical activity time (in minutes). The requirements for participation – that was voluntary and not compensated – were at least eight weekly work hours, daily smartphone use time for at least 65 min (to prevent a complete abstinence in smartphone and combination groups), and engagement in physical activity for no more than one hour daily (to ensure some comparability between the participants). Also, to ensure some comparability, we excluded performance athletes and persons with severe physical disabilities (e.g., wheelchair users) from participation. All participants fulfilled the requirements.

At the beginning of the baseline survey, we assigned the participants to one of the four groups randomly according to age and gender. The same day, we sent the intervention groups an e-mail that included group-specific instructions. The smartphone group and the combination group required to cut down their non-work-related smartphone use time by 60 min a day. To clarify the instruction, we provided each participant with a precise maximal time that the person was allowed to spend on daily smartphone use during the intervention period (= daily smartphone use time indicated in the initial e-mail to the principal investigators minus 60 min). For example, if the daily smartphone use time was about 180 min, the participant should engage in smartphone use for no longer than 120 min daily (180 min – 60 min = 120 min).

The physical activity group and the combination group should increase their physical activity time by 30 min a day. To clarify this instruction, we informed each participant about a precise minimal time that the person should engage in physical activity throughout a day during the intervention period (= daily physical activity time indicated in the initial e-mail to the principal investigators plus 30 min). We did not want to restrict our participants to specific forms of physical activity. Instead, we provided them with examples of potential forms of physical activity (e.g., jogging, cycling, swimming, workout, football, basketball, gymnastics, dancing).

In addition, the e-mail of the three intervention groups included a Microsoft Word document ("daily compliance-diary"). The diary consisted of a table for the daily entry of the compliance with the group-specific instruction (0 = *no*, 1 = *yes*). In case of non-compliance, participants could shortly explain the reason for it. After the intervention period, participants e-mailed the compliance-diary back to the principal investigators. Following Brailovskaia, Delveaux, et al. (2023) compliance was assessed when participants complied for at least five of the seven intervention days. Following Tromholt (2016), we kept non-compliers in the samples. Notably, their exclusion from the samples did not show significant changes of the main findings. To prevent increased attention on smartphone use and physical activity, the control group did not receive a compliance-diary.

The study procedures were carried out in accordance with the ethical standards as laid down in the Declaration of Helsinki. The present study was approved by the responsible Ethics Committee in Germany (approval number: 687) and it was preregistered with AsPredicted.org on March 22, 2022 (registration number: #91396). Participants were properly informed about the study and provided informed consent to participate via an online form.

The total sample included 278 participants (all Caucasian) who completed all surveys. Table 1 shows their demographic data.

2.2.1. Smartphone group

We assessed overall 87 persons to the smartphone group. At different stages of the investigation, 14 individuals (16.1 %) dropped out. Thus, the smartphone group included 73 participants who completed all surveys. Analyses of the compliance-diaries revealed a compliance rate of 94.5 % ($n = 69$).

2.2.2. Physical activity group

Overall, 88 persons were assessed to the physical activity group. Of them, 19 individuals (21.5 %) dropped out. Thus, the physical activity group consisted of 69 participants who completed all surveys. The compliance rate was 91.3 % ($n = 63$).

2.2.3. Combination group

Overall, 84 persons were assessed to the combination group. Of them, 12 individuals (14.3 %) dropped out. Thus, the combination group consisted of 72 participants who completed all surveys. The compliance rate was 90.3 % ($n = 65$).

2.2.4. Control group

Overall, 83 persons were assessed to the control group. Of them, 19 individuals (22.3 %) dropped out. Thus, the control group consisted of 64 participants who completed all surveys.

Analyses of variance (ANOVAs) and Chi-Square tests revealed no significant differences in terms of demographic variables neither between the four investigated groups, nor between persons who dropped out and those who participated in all surveys. A priori calculated power analyses (G*Power program, version 3.1) showed that at least a total sample size of $N = 232$ ($n = 58$ per group) was required for valid results (repeated measure ANOVAs, within-between factor-design; power ≥ 0.80, $\alpha = 0.05$, effect size: $f = 0.10$; Mayr et al., 2007). Thus, our sample (total, group-specific) was large enough for valid findings.

2.3. Measures

All used instruments have been well validated by previous research (see e.g., Lukat et al., 2016). To avoid an overload of the participants and to reduce the drop-out risk over the three measurements, the variables of interest were assessed with short (version) scales if available.

2.3.1. Work-related measures

2.3.1.1. Work satisfaction. The subscale "general work satisfaction" of the General and Facet-Specific Job Satisfaction Scale (KAFA; original German version: Haarhaus, 2015) assessed general work satisfaction. The five items (e.g., "All in all, my job is pleasant") are rated on a 5-point Likert-type scale (1 = *strongly disagree*, 5 = *strongly agree*). The two negatively formulated items were recoded.

2.3.1.2. Work motivation. We measured work motivation by the subscale "work motivation" of the Diagnostic Instrument for Work Motivation (DIAMO; original German version: Ranft et al., 2009). The six items (e.g., "My work is the center of my life") are rated on a 5-point Likert-type scale (1 = *does not apply to me*, 5 = *strongly applies to me*).

2.3.1.3. Work overload. The subscale "qualitative and quantitative work overload" of the brief version of the Salutogenic Subjective Working Analyses Questionnaire (SALSA-K; original German version: Rimann & Udris, 2018; see also Scherf, 2006) assessed the level of experienced work overload. The five items (e.g., "Sometimes the work is too difficult") are rated on a 5-point Likert-type scale (1 = *not at all*, 5 = *almost always*).

2.3.1.4. Work-life balance. The Trierer Scale to Measure Work-Life Balance (TKS-WLB; original German version: Syrek et al., 2011) measured the perceived work-life balance. The five items (e.g., "I can fulfill the demand of my private life and the demands of my work equally well") are rated on a 6-point Likert-type scale (1 = *strongly disagree*, 6 = *strongly agree*). We recoded the negatively formulated Item 2.

Table 1
Demographic data of the four investigated groups (baseline).

	Smartphone group, $N = 73$	Physical activity group, $N = 69$	Combination group, $N = 72$	Control group, $N = 64$
Age in years, *M* (*SD; Min-Max*)	27.85 (10.18; 21–62)	26.55 (7.00; 21–56)	27.78 (8.35; 21–63)	28.25 (9.72; 21–63)
Gender (women: %, men: %)	64.4, 35.6	59.4, 40.6	66.7, 33.3	67.2, 32.8
Marital status (%)				
Single	41.1	43.5	44.4	39.1
With romantic partner	46.6	47.8	47.2	46.9
Married	12.3	8.7	8.3	14.1
Employment relationship (%)				
Privat sector	31.5	36.2	33.3	31.3
Public service	58.9	58.0	59.7	59.4
Freelance/self-employed	9.6	5.8	6.9	9.4
Employment sector (%)				
Building industry and architecture	5.5	4.3	9.7	6.3
Computer and IT	5.5	7.2	8.3	3.1
Education, training, and social services	30.1	23.2	20.8	32.8
Finance and insurance	9.6	5.8	2.8	4.7
Gastronomy, consumption, and tourism	16.4	20.3	18.1	17.2
Health and pharma	19.2	20.3	26.4	25.0
Metal and electronics	6.8	13.0	6.9	6.3
Transport and logistics	6.8	5.8	6.9	4.7
Weekly work hours (%)				
8 to 10 h	1.4	2.9	5.6	0
11 to 20 h	42.5	36.2	34.7	28.1
21 to 30 h	21.9	29.0	25.0	29.7
31 to 40 h	23.3	26.1	25.0	32.8
41 to 50 h	11.0	5.8	9.7	9.4

Notes. M = mean; *SD* = standard deviation; *Min* = minimum; *Max* = maximum; due to rounding, sums are not always 100 %.

2.3.2. Mental health-related, smartphone use-related and physical activity-related measures

2.3.2.1. Depressive symptoms. We assessed depressive symptoms by the subscale “depressive symptoms” of the Depression Anxiety Stress Scales 21 (DASS-21; original version: Lovibond & Lovibond, 1995; German version: Nilges & Essau, 2015). The seven items (e.g., “I couldn't seem to experience any positive feeling at all”) are rated on a 4-point Likert-type scale (0 = *did not apply to me at all*, 3 = *applied to me very much or most of the time*).

2.3.2.2. Positive mental health. We measured PMH by the unidimensional Positive Mental Health Scale (PMH-Scale; original German version: Lukat et al., 2016). The nine items (e.g., “I enjoy my life”) focus on subjective and psychological aspects of well-being. They are rated on 4-point Likert-type scale (0 = *do not agree*, 3 = *agree*).

2.3.2.3. Sense of control. Sense of control was assessed by the Sense of Control Scale (SoC-Scale; original German version: Niemeyer et al., 2019). This instrument includes two items: “Do you experience important areas of your life (i.e., work, free-time, family, etc.) to be uncontrollable, meaning that you cannot, or barely can, influence them?” and “Do you experience these important areas of your life as unpredictable or inscrutable?”. Both items are rated on a 5-point Likert-type scale (0 = *not at all*, 4 = *very strong*). We recoded both negatively formulated items.

2.3.2.4. Problematic smartphone use. The short version of the Smartphone Addiction Scale (SAS-SV; original version: Kwon et al., 2013; German version: Randler et al., 2016) assessed PSU. The ten items (e.g., “I will never give up using my smartphone even when my daily life is already greatly affected by it”) are rated on a 6-point Likert-type scale (1 = *strongly disagree*, 6 = *strongly agree*).

Table 2
Descriptive statistics of investigated variables (baseline, post-intervention, follow-up).

	Group	Baseline		Post-intervention		Follow-up	
		M(SD)	*α*	*M(SD)*	*α*	*M(SD)*	*α*
Work satisfaction	Total sample	18.91 (4.03)	0.852				
	Smartphone	18.66 (4.23)	0.850	19.74 (4.09)	0.822	20.58 (3.16)	0.700
	Physical activity	18.94 (3.83)	0.839	18.81 (4.00)	0.837	19.29 (3.54)	0.812
	Combination	19.19 (3.64)	0.798	20.61 (3.13)	0.848	20.82 (3.11)	0.807
	Control	18.94 (4.47)	0.907	19.05 (4.79)	0.906	18.59 (4.90)	0.925
Work motivation	Total sample	18.63 (4.63)	0.822				
	Smartphone	18.77 (4.71)	0.852	20.26 (4.94)	0.844	20.71 (3.97)	0.785
	Physical activity	18.71 (4.74)	0.829	18.91 (5.08)	0.812	19.03 (5.24)	0.874
	Combination	18.56 (4.54)	0.790	19.69 (4.78)	0.857	20.85 (3.83)	0.761
	Control	18.45 (4.63)	0.831	18.13 (4.90)	0.819	18.34 (5.28)	0.853
Work overload	Total sample	11.67 (3.60)	0.801				
	Smartphone	11.59 (3.61)	0.787	10.89 (4.27)	0.876	10.45 (3.59)	0.848
	Physical activity	11.62 (3.65)	0.796	11.39 (3.66)	0.853	11.16 (3.25)	0.822
	Combination	11.67 (3.43)	0.814	10.79 (3.69)	0.835	9.94 (2.96)	0.773
	Control	11.83 (3.80)	0.816	11.73 (3.88)	0.866	11.78 (3.44)	0.846
Work-life balance	Total sample	20.71 (4.94)	0.881				
	Smartphone	20.74 (5.13)	0.910	21.44 (5.09)	0.908	22.55 (3.83)	0.811
	Physical activity	20.80 (5.08)	0.895	21.42 (4.46)	0.838	21.72 (4.57)	0.893
	Combination	20.60 (4.86)	0.851	21.89 (3.93)	0.880	22.96 (3.63)	0.841
	Control	20.69 (4.79)	0.866	20.95 (4.08)	0.829	20.83 (4.29)	0.836
Depressive symptoms	Total sample	3.75 (3.39)	0.843				
	Smartphone	3.92 (3.94)	0.872	3.07 (3.47)	0.888	2.67 (2.55)	0.773
	Physical activity	3.59 (3.54)	0.849	2.87 (2.87)	0.857	3.01 (3.40)	0.856
	Combination	3.74 (3.10)	0.844	2.40 (2.57)	0.807	2.14 (2.86)	0.849
	Control	3.75 (2.88)	0.786	3.78 (3.43)	0.890	3.61 (3.11)	0.857
Positive mental health	Total sample	18.88 (467)	0.887				
	Smartphone	19.07 (4.96)	0.893	19.36 (5.39)	0.931	20.12 (4.35)	0.906
	Physical activity	18.90 (4.42)	0.865	19.84 (4.17)	0.887	19.78 (4.66)	0.913
	Combination	18.69 (4.52)	0.881	20.46 (3.94)	0.872	20.38 (4.58)	0.907
	Control	18.86 (4.87)	0.912	19.09 (4.86)	0.894	18.89 (5.02)	0.913
Sense of control	Total sample	5.63 (1.64)	0.784				
	Smartphone	5.67 (1.72)	0.773	6.21 (1.56)	0.750	6.30 (1.42)	0.864
	Physical activity	5.75 (1.60)	0.750	6.38 (1.51)	0.794	5.81 (1.63)	0.857
	Combination	5.60 (1.66)	0.780	5.82 (1.76)	0.899	6.33 (1.32)	0.807
	Control	5.48 (1.56)	0.851	5.59 (1.47)	0.724	5.45 (1.51)	0.868
Problematic Smartphone use	Total sample	26.05 (9.58)	0.886				
	Smartphone	26.07 (10.13)	0.888	24.89 (9.69)	0.887	22.82 (9.37)	0.903
	Physical activity	26.77 (9.66)	0.893	26.75 (11.05)	0.912	25.61 (10.43)	0.908
	Combination	25.63 (9.98)	0.898	23.08 (8.75)	0.888	21.83 (7.85)	0.860
	Control	25.75 (8.52)	0.866	25.52 (9.05)	0.907	25.69 (10.06)	0.936
Daily non-work-related Smartphone time (in minutes)	Total sample	188.43 (112.82)					
	Smartphone	194.44 (153.25)		127.03 (86.12)		153.42 (94.00)	
	Physical activity	191.04 (106.16)		187.57 (134.09)		178.36 (114.16)	
	Combination	186.75 (78.98)		136.74 (92.72)		131.82 (76.73)	
	Control	180.66 (99.04)		174.22 (91.67)		178.67 (95.48)	
Weekly physical activity time (in minutes)	Total sample	103.59 (111.91)					
	Smartphone	96.44 (118.12)		156.78 (156.26)		149.66 (188.76)	
	Physical activity	105.36 (111.26)		289.71 (160.22)		206.01 (179.22)	
	Combination	109.50 (97.97)		318.33 (225.04)		250.29 (217.28)	
	Control	103.20 (121.81)		106.56 (149.72)		107.58 (149.80)	

Notes. Total Sample: $N = 278$, Smartphone Group: $N = 73$, Physical Activity Group: $N = 69$, Combination Group: $N = 72$, Control Group: $N = 64$; Baseline to Follow-Up = measurement time points; M = Mean; SD=Standard Deviation.

2.3.2.5. Daily non-work-related smartphone use time. Participants indicated the duration of their daily non-work-related smartphone use time (in minutes). We defined non-work-related smartphone use as each private use of the smartphone during the day (including work hours and leisure). Thus, smartphone use that was necessary for a work-specific task was not included in this definition. In contrast, scrolling on Instagram because of boredom during work hours belonged to non-work-related smartphone use. If available, participants referred to the time tracked by their smartphone. If not available, they estimated the use time as accurately as possible. Overall, 225 (80.9 %) persons indicated to refer to tracked use time.

2.3.2.6. Weekly physical activity time. Following Fuchs et al. (2015; original German version), participants indicated whether they had engaged in any form of physical activity during the past week (0 = *no*, 1 = *yes*). If they had done so, they named up to three activities that they engaged in. For each activity, they indicated how many times they had engaged in it and for how long (in minutes), respectively. If available, they referred to the time tracked by activity/fitness trackers. If not available, they estimated their activity time as accurately as possible. Overall, 97 (34.9 %) persons indicated tracked physical activity time. To calculate the weekly physical activity time, we first multiplied times and minutes (times*minutes) for each activity. Then, we summed up the product values. For participants who did not engage in any physical activity, we entered a zero.

For all used instruments higher (sum) scores indicated higher levels of the measured variable. All variables were assessed at the three measurement time points in all groups. Table 2 shows the internal scale reliability of all scales for the total sample at the baseline and for the four groups at each measurement time point.

2.4. Statistical analysis

Statistical analyses were conducted with SPSS 28 (IBM Corp, 2021). There were no missing data. All variables of interest were close to normally distributed (indicated by analyses of skewness, <2.00, and kurtosis, <7.00; see also Hair et al., 2010). After descriptive analyses, we calculated repeated ANOVAs (within-between factor-design) to test possible time effects (up to three measurement time points) and to compare the four investigated groups. There was a violation of the assumption of sphericity (Mauchly's test) for all variables. Therefore, we applied the Greenhouse-Geisser correction (ε). Partial eta-squared (η_p^2)

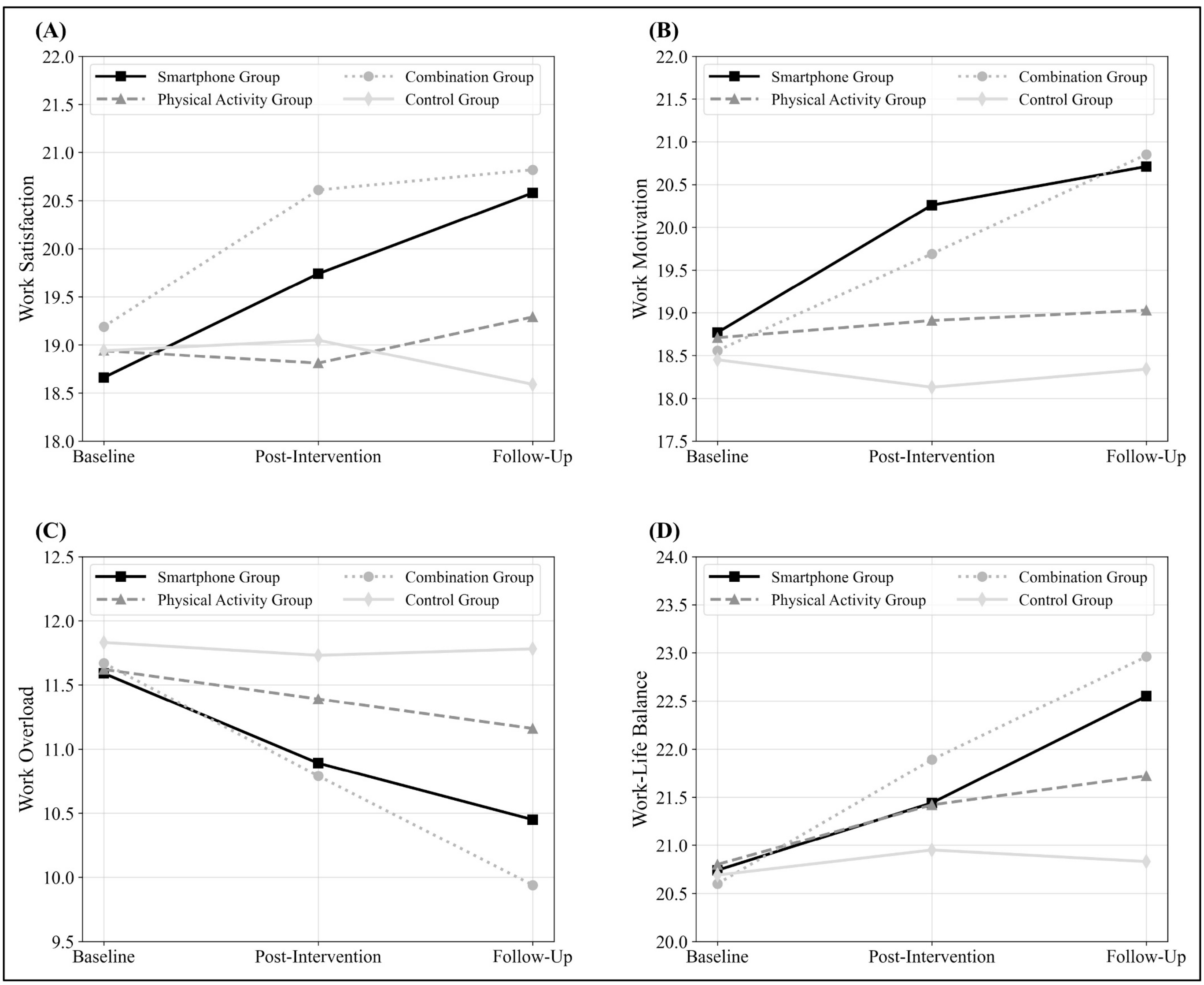

Fig. 1. Results of repeated measure analyses of variance (ANOVAs) for work-related outcomes: (A) work satisfaction, (B) work motivation, (C) work overload, and (D) work-life balance (Smartphone Group: $N = 73$, Physical Activity Group: $N = 69$, Combination Group: $N = 72$, Control Group: $N = 64$; Baseline to Follow-up = measurement time points).

was included as the effect-size measure of main effects (measurement time point; group condition) and of interaction effect (measurement time point*group condition). For η_p^2, values ≥0.01 reveal small effects, values ≥0.06 reveal medium high effects, and values ≥0.14 reveal large effects (Cohen, 1988). Cohen's d served as effect-size measure of post-hoc comparisons between groups and Cohen's $d_{Repeated\ Measures}$ served as effect-size measure of post-hoc comparisons within groups. For Cohen's d and Cohen's $d_{Repeated\ Measures}$, values ≥0.20 reveal small effects, values between ≥0.50 reveal medium high effects, and values ≥0.80 reveal large effects (Cohen, 1988). All post-hoc comparisons were Bonferroni-corrected (level of significance: $p < .05$, two-tailed).

3. Results

Table 2 shows descriptive statistics of the investigated variables in the total sample at the baseline and in the four groups at each measurement time point. Considering the different interventions in the intervention/experimental groups and the absence of any intervention in the control group, the total sample values are no longer informative at post-intervention and two-week follow-up measurement. Fig. 1 (work-related outcomes) and Fig. 2 (mental health-related, smartphone use-related and physical activity-related outcomes) visualize results of the ANOVAs. Table 3 shows results of the pairwise comparisons within the four groups, and Table 4 reveals results of the pairwise comparisons between the groups.

For work satisfaction, the ANOVA revealed a significant main effect for measurement time point, $F(1.96, 537.864) = 12.317$, $p < .001$, $\eta_p^2 = 0.043$ (small effect), no significant main effect for group condition, $F(3, 274) = 2.226$, $p = .085$, and a significant interaction effect, $F(5.89, 537.864) = 4.532$, $p < .001$, $\eta_p^2 = 0.047$ (small effect). Pairwise comparisons showed a significant increase of work satisfaction between all measurements in the smartphone group, and from baseline to post-intervention and to follow-up measurement in the combination group (small effects; see Table 3). Work satisfaction was significantly higher in the smartphone group and the combination group than in the control group at follow-up measurement (small to medium effects; see Table 4).

For work motivation, we found a significant main effect for measurement time point, $F(1.94, 532.398) = 8.594$, $p < .001$, $\eta_p^2 = 0.030$ (small effect), no significant main effect for group condition, $F(3, 274) = 2.394$, $p = .069$, and a significant interaction effect, $F(5.83, 532.398) = 2.657$, $p = .016$, $\eta_p^2 = 0.028$ (small effect). Pairwise comparisons showed a significant increase of work motivation from baseline to post-intervention and to follow-up measurement in the smartphone group, and from baseline to follow-up measurement in the combination group (small effects; see Table 3). Work motivation was significantly higher in the smartphone group and the combination group than in the control group at follow-up measurement (medium effects; see Table 4).

For work overload, the ANOVA showed a significant main effect for measurement time point, $F(1.98, 543.35) = 11.839$, $p < .001$, $\eta_p^2 = 0.041$ (small effect), no significant main effect for group condition, $F(3, 274) = 1.270$, $p = .285$, and a significant interaction effect, $F(5.95, 543.35) = 2.259$, $p = .037$, $\eta_p^2 = 0.024$ (small effect). Pairwise comparisons revealed a significant decrease of work overload from baseline to follow-up measurement in the smartphone group and between all measurements in the combination group (small to medium effects; see Table 3). Work overload was significantly lower in the combination group than in the control group at follow-up measurement (medium effect; see Table 4).

For work-life balance, we found a significant main effect for measurement time point, $F(1.92, 524.75) = 17.687$, $p < .001$, $\eta_p^2 = 0.061$ (medium effect), no significant main effect for group condition, $F(3, 274) = 0.768$, $p = .513$, and a significant interaction effect, $F(5.75, 524.75) = 2.527$, $p = .022$, $\eta_p^2 = 0.027$ (small effect). Pairwise comparisons revealed a significant increase of the work-life balance between baseline and follow-up measurement as well as between post-intervention and follow-up measurement in the smartphone group, and from baseline to follow-up measurement in the combination group (small to medium effects; see Table 3). Work-life balance was significantly higher in the combination group than in the control group at follow-up measurement (medium effect; see Table 4).

For depressive symptoms, the ANOVA showed a significant main effect for measurement time point, $F(1.78, 486.84) = 18.071$, $p < .001$, $\eta_p^2 = 0.062$ (medium effect), no significant main effect for group condition, $F(3, 274) = 1.330$, $p = .265$, and a significant interaction effect, $F(5.33, 486.84) = 2.645$, $p = .020$, $\eta_p^2 = 0.028$ (small effect). Pairwise comparisons revealed a significant decrease of depressive symptoms between baseline and post-intervention measurement as well as between baseline and follow-up measurement in the smartphone group and in the combination group, and between baseline and post-intervention measurement in the physical activity group (small to medium effects; see Table 3). Depressive symptoms were significantly lower in the combination group than in the control group at follow-up measurement (small effect; see Table 4).

For PMH, the ANOVA provided a significant main effect for measurement time point, $F(1.93, 529.81) = 11.480$, $p < .001$, $\eta_p^2 = 0.040$ (small effect), no significant main effect for group condition, $F(3, 274) = 0.522$, $p = .668$, and a significant interaction effect, $F(5.80, 529.81) = 2.249$, $p = .038$, $\eta_p^2 = 0.024$ (small effect). As revealed by pairwise comparisons, PMH significantly increased between baseline and follow-up measurement in the smartphone group, as well as between baseline and post-intervention measurement and between baseline and follow-up measurement in the combination group (small effects; see Table 3).

For sense of control, the ANOVA showed a significant main effect for measurement time point, $F(1.99, 545.75) = 10.475$, $p < .001$, $\eta_p^2 = 0.037$ (small effect), no significant main effect for group condition, $F(3, 274) = 2.345$, $p = .073$, and a significant interaction effect, $F(5.98, 545.75) = 4.199$, $p < .001$, $\eta_p^2 = 0.044$ (small effect). Pairwise comparisons indicated a significant increase sense of control between baseline and the other measurements in the smartphone group, between baseline and post-intervention measurement as well as between post-intervention and follow-up measurement in the physical activity group, and between baseline and follow-up measurement as well as between post-intervention and follow-up measurement in the combination group (small effects; see Table 3). Sense of control was significantly higher in the physical activity group than in the control group at post-intervention measurement, and in the smartphone and the combination groups than in the control group at follow-up measurement (medium effects; see Table 4).

For PSU, the ANOVA provided a significant main effect for measurement time point, $F(1.90, 521.58) = 16.985$, $p < .001$, $\eta_p^2 = 0.058$ (small effect), no significant main effect for group condition, $F(3, 274) = 1.366$, $p = .253$, and a significant interaction effect, $F(5.71, 521.58) = 3.446$, $p = .003$, $\eta_p^2 = 0.036$ (small effect). Pairwise comparisons showed a significant decrease of PSU between baseline and follow-up measurement as well as between post-intervention and follow-up measurement in the smartphone group, and between baseline and the other measurements in the combination group (small to medium effects; see Table 3).

For non-work-related time spent daily on smartphone use, the ANOVA showed a significant main effect for measurement time point, $F(1.82, 499.06) = 19.921$, $p < .001$, $\eta_p^2 = 0.068$ (medium effect), no significant main effect for group condition, $F(3, 274) = 2.208$, $p = .087$, and a significant interaction effect, $F(5.46, 499.06) = 5.214$, $p < .001$, $\eta_p^2 = 0.054$ (small effect). Pairwise comparisons showed a significant decrease of daily non-work-related smartphone use time between baseline and the other measurements in the smartphone group and the combination group. The use time increased again significantly between post-intervention and follow-up measurement in the smartphone group (small to large effects; see Table 3). Use time was significantly lower in the smartphone group than in the physical activity and the control group at post-intervention measurement; it was significantly lower in the combination group than in the physical activity group at post-

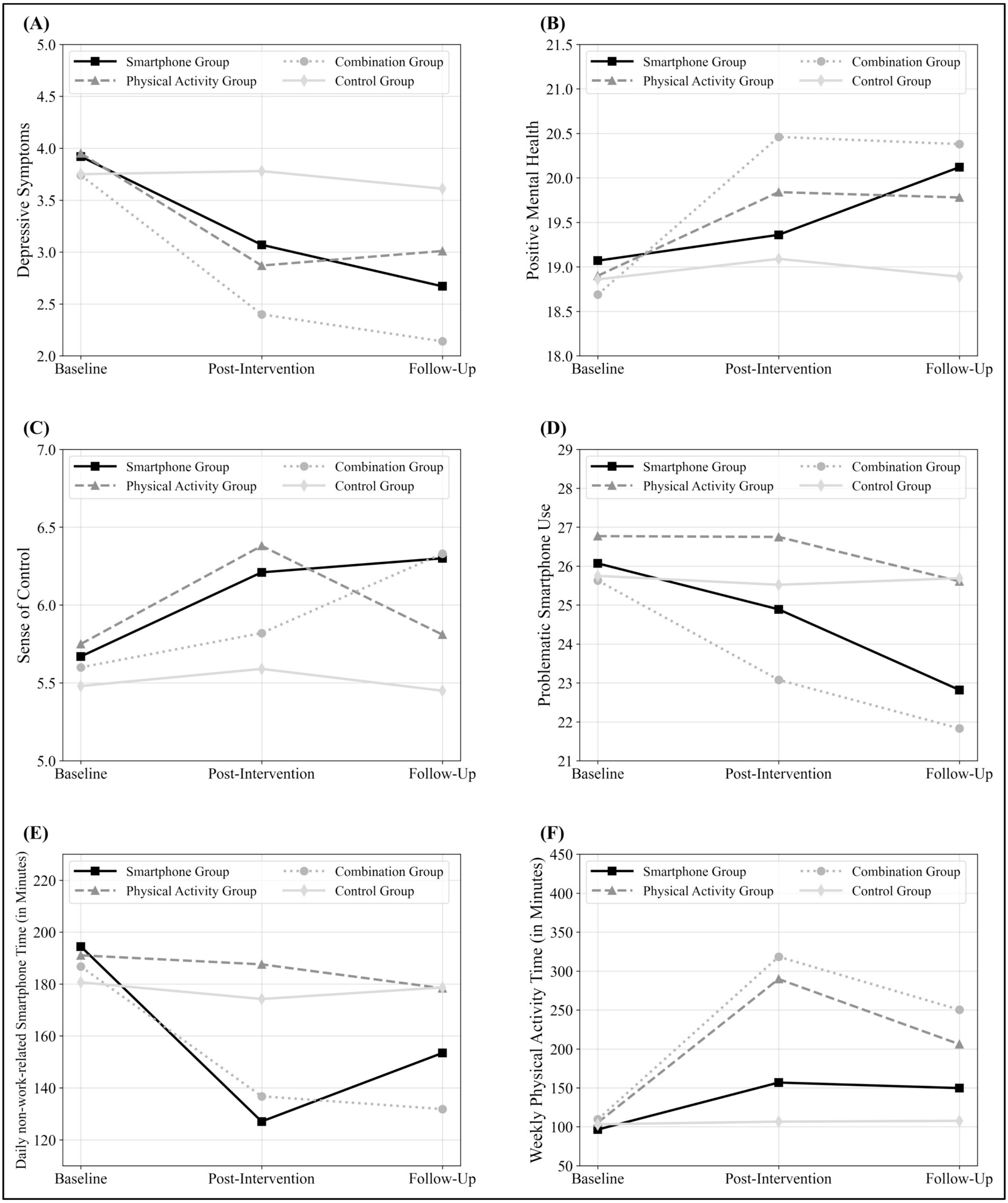

Fig. 2. Results of repeated measure analyses of variance (ANOVAs) for mental health-related, smartphone use-related and physical activity-related outcomes: (A) depressive symptoms, (B) positive mental health, (C) sense of control, (D) problematic smartphone use, (E) daily time spent on non-work-related smartphone use, (F) weekly time spent on physical activity (Smartphone Group: $N = 73$, Physical Activity Group: $N = 69$, Combination Group: $N = 72$, Control Group: $N = 64$; Baseline to Follow-up = measurement time points).

Table 3
Pairwise comparisons of time points within groups (baseline to follow-up).

	Group	Baseline vs. post-intervention		Baseline vs. follow-up		Post-intervention vs. follow-up	
		md, 95%*CI*	d_{RM}	md, 95%*CI*	d_{RM}	md, 95%*CI*	d_{RM}
Work satisfaction	Smartphone	**−1.082*, [−1.995, −0.209]**	**0.33**	**−1.918*, [−2.851, −0.985]**	**0.44**	**−0.836*, [−1.665, −0.007]**	**0.25**
	Physical activity	0.058, [−0.840, 0.956]		−0.420, [−1.380, 0.539]		−0.478, [−1.331, 0.374]	
	Combination	**−1.417*, [−2.296, −0.537]**	**0.40**	**−1.625*, [−2.564, −0.686]**	**0.41**	−0.208, [−1.043, 0.626]	
	Control	−0.109, [−1.042, 0.823]		0.344, [−0.652, 1.340]		0.453, [−0.432, 1.338]	
Work motivation	Smartphone	**−1.493*, [−2.676, −0.310]**	**0.27**	**−1.945*, [−3.304, −0.586]**	**0.30**	−0.452, [−1.677, 0.773]	
	Physical activity	−0.203, [−1.420, 1.014]		−0.319, [−1.706, 1.069]		−0.116, [−1.377, 1.145]	
	Combination	−1.125, [−2.316, 0.066]		**−2.278*, [−3.636, −0.920]**	**0.37**	−1.153, [−2.387, 0.082]	
	Control	0.328, [−0.935, 1.592]		0.109, [−1.331, 1.550]		−0.219, [−1.550, 1.331]	
Work overload	Smartphone	0.699, [−0.143, 1.540]		**1.137*, [0.313, 1.961]**	**0.38**	0.438, [−0.340, 1.216]	
	Physical activity	0.232, [−0.634, 1.098]		0.464, [−0.383, 1.311]		0.232, [−0.568, 1.032]	
	Combination	**0.875*, [0.027, 1.723]**	**0.35**	**1.722*, [0.893, 2.552]**	**0.61**	**0.847*, [0.064, 1.631]**	**0.38**
	Control	0.094, [−0.805, 0.993]		0.047, [−0.833, 0.927]		−0.047, [−0.878, 0.784]	
Work-life balance	Smartphone	−0.699, [−1.742, 0.345]		**−1.808*, [−2.930, −0.687]**	**0.42**	**−1.110*, [−2.041, −0.178]**	**0.26**
	Physical activity	−0.623, [−1.696, 0.450]		−0.928, [−2.081, 0.226]		−0.304, [−1.263, 0.654]	
	Combination	**−1.292*, [−2.342, −0.241]**	**0.27**	**−2.361*, [−3.490, −1.232]**	**0.54**	**−1.069*, [−2.008, −0.131]**	**0.33**
	Control	−0.266, [−1.380, 0.849]		−0.141, [−1.338, 1.057]		0.125, [−0.870, 1.120]	
Depressive symptoms	Smartphone	**0.849*, [0.216, 1.483]**	**0.32**	**1.247*, [0.393, 2.100]**	**0.32**	0.397, [−0.313, 1.108]	
	Physical activity	**0.725*, [0.073, 1.376]**	**0.35**	0.580, [−0.298, 1.458]		−0.145, [−0.876, 0.586]	
	Combination	**1.333*, [0.696, 1.971]**	**0.51**	**1.597*, [0.738, 2.457]**	**0.44**	0.264, [−0.452, 0.979]	
	Control	−0.031, [−0.708, 0.645]		0.141, [−0.771, 1.052]		0.172, [−0.587, 0.931]	
Positive mental health	Smartphone	−0.288, [−1.275, 0.699]		**−1.055*, [−2.104, −0.005]**	**0.35**	−0.767, [−1.659, 0.125]	
	Physical activity	−0.942, [−1.957, 0.073]		−0.884, [−1.963, 0.195]		0.058, [−0.195, 1.963]	
	Combination	**−1.764*, [−2.758, −0.770]**	**0.42**	**−1.681*, [−2.737, −0.624]**	**0.40**	0.083, [−0.815, 0.981]	
	Control	−0.234, [−1.288, 0.820]		−0.031, [−1.152, 1.090]		0.203, [−0.749, 1.156]	
Sense of control	Smartphone	**−0.534*, [−0.963, −0.106]**	**0.29**	**−0.630*, [−1.069, −0.192]**	**0.37**	−0.096, [−0.511, 0.319]	
	Physical activity	**−0.623*, [−1.064, −0.182]**	**0.41**	−0.058, [−0.509, 0.393]		**0.565*, [0.139, 0.992]**	**0.33**
	Combination	−0.222, [−0.654, 0.209]		**−0.736*, [−1.178, −0.295]**	**0.41**	**−0.514*, [−1.932, −0.096]**	**0.32**
	Control	−0.109, [−0.567, 0.348]		0.031, [−0.437, 0.500]		0.141, [−0.302, 0.584]	
Problematic Smartphone use	Smartphone	1.178, [−0.606, 2.962]		**3.247*, [1.525, 4.968]**	**0.49**	**2.068*, [0.600, 3.537]**	**0.38**
	Physical activity	0.014, [−1.820, 1.849]		1.159, [−0.612, 2.930]		1.145, [−0.366, 2.656]	
	Combination	**2.542*, [0.746, 4.338]**	**0.35**	**3.792*, [2.058, 5.525]**	**0.53**	1.250, [−0.229, 2.729]	
	Control	0.234, [−1.671, 2.139]		0.063, [−1.776, 1.901]		−0.172, [−1.741, 1.397]	
Daily non-work-related Smartphone time (in minutes)	Smartphone	**67.411*, [39.319, 95.503]**	**0.41**	**41.014*, [13.800, 68.227]**	**0.24**	**−26.397*, [−47.768, −5.027]**	**0.34**
	Physical activity	3.478, [−25.417, 32.373]		12.681, [−15.310, 40.672]		9.203, [−12.778, 31.184]	
	Combination	**50.014*, [21.727, 78.300]**	**0.61**	**54.931*, [27.529, 82.332]**	**0.93**	4.917, [−16.602, 26.435]	
	Control	6.438, [−23.565, 36.440]		1.984, [−27.079, 31.048]		−4.453, [−27.277, 18.371]	
Weekly physical activity time (in minutes)	Smartphone	**−60.342*, [−104.140, −16.545]**	**0.55**	**−53.219*, [−104.827, −1.611]**	**0.38**	7.123, [−43.170, 57.417]	
	Physical activity	**−0.184.348*, [−229.397, −139.298]**	**1.51**	**−100.652*, [−153.735, −47.570]**	**0.79**	**83.696*, [31.965, 135.427]**	**0.49**
	Combination	**−0.208.833*, [−252.934, −164.732]**	**2.05**	**−140.792*, [−192.757, −88.827]**	**1.18**	**68.042*, [17.400, 118.683]**	**0.27**
	Control	−3.359, [−50.136, 43.417]		−4.375, [−59.492, 50.742]		−1.016, [−54.729, 52.698]	

Notes. Smartphone Group: $N = 73$, Physical Activity Group: $N = 69$, Combination Group: $N = 72$, Control Group: $N = 64$; Baseline to Follow-up = measurement time points; md = mean difference; *CI*=Confidence Interval; d_{RM} = Cohen's $d_{\text{Repeated Measures}}$, effect-size measure of post-hoc comparisons within groups; pairwise comparisons are Bonferroni-corrected ($p < .050$, two-tailed); significant results are marked in bold. $^{*}p < .050$.

Table 4
Pairwise comparisons between the four groups (baseline to follow-up).

	Groups	Baseline		Post-intervention		Follow-up	
		md, 95%*CI*	d	md, 95%*CI*	d	md, 95%*CI*	d
Work satisfaction	Smartphone vs. physical activity	−0.212, [−2.017, 1.593]		0.928, [−0.867, 2.723]		1.285, [−0.370, 2.941]	
	Smartphone vs. combination	−0.537, [−2.323, 1.249]		−0.871, [−2.647, 0.904]		−0.244, [−1.881, 1.393]	
	Smartphone vs. control	−0.280, [−2.121, 1.561]		0.693, [−1.138, 2.524]		**1.982*, [0.294, 3.670]**	**0.49**
	Physical activity vs. combination	−0.325, [−2.136, 1.487]		−1.800, [−3.601, 0.002]		−1.530, [−3.190, 0.131]	
	Physical activity vs. control	−0.068, [−1.934, 1.798]		−0.235, [−2.091, 1.620]		0.696, [−1.015, 2.407]	
	Combination vs. control	0.257, [−1.590, 2.104]		1.564, [−0.272, 3.401]		**2.226*, [0.532, 3.919]**	**0.55**
Work motivation	Smartphone vs. physical activity	0.057, [−2.020, 2.134]		1.347, [−0.851, 3.546]		1.683, [−0.369, 3.736]	
	Smartphone vs. combination	0.198, [−1.857, 2.253]		0.556, [−1.609, 2.741]		−0.135, [−2.165, 1.895]	
	Smartphone vs. control	0.314, [−1.805, 2.433]		2.135, [−0.107, 4.378]		**2.369*, [0.275, 4.462]**	**0.51**
	Physical activity vs. combination	0.141, [−1.944, 2.225]		−0.781, [−2.987, 1.425]		−1.818, [−3.878, 0.241]	
	Physical activity vs. control	0.257, [−1.890, 2.404]		−0.781, [−2.987, 1.425]		0.685, [−1.436, 2.807]	
	Combination vs. control	0.116, [−2.009, 2.242]		1.569, [−0.680, 3.819]		**2.503*, [0.404, 4.603]**	**0.55**
Work overload	Smartphone vs. physical activity	−0.034, [−1.649, 1.581]		−0.501, [−2.234, 1.232]		−0.707, [−2.187, 0.772]	
	Smartphone vs. combination	−0.078, [−1.675, 1.520]		0.099, [−1.616, 1.813]		0.508, [−0.956, 1.971]	
	Smartphone vs. control	−0.239, [−1.886, 1.408]		−0.844, [−2.612, 0.924]		−1.329, [−2.838, 0.180]	
	Physical activity vs. combination	−0.043, [−1.664, 1.577]		0.600, [−1.139, 2.339]		1.215, [−0.269, 2.699]	
	Physical activity vs. control	−0.205, [−1.874, 1.464]		−0.343, [−2.134, 1.448]		−0.622, [−2.151, 0.907]	
	Combination vs. control	−0.161, [−1.814, 1.491]		−0.943, [−2.716, 0.831]		**−1.837*, [−3.351, −0.323]**	**0.58**
Work-life balance	Smartphone vs. physical activity	−0.057, [−2.275, 2.161]		0.018, [−1.956, 1.992]		0.823, [−0.999, 2.646]	
	Smartphone vs. combination	0.143, [−2.052, 2.337]		−0.451, [−2.403, 1.502]		−0.410, [−2.213, 1.393]	
	Smartphone vs. control	0.052, [−2.210, 2.314]		0.485, [−1.528, 2.498]		1.720, [−0.139, 3.579]	
	Physical activity vs. combination	0.200, [−2.026, 2.425]		−0.469, [−2.449, 1.512]		−1.234, [−3.063, 0.595]	
	Physical activity vs. control	0.110, [−2.183, 2.402]		0.467, [−1.573, 2.507]		0.897, [−0.987, 2.780]	
	Combination vs. control	−0.090, [−2.360, 2.179]		0.936, [−1.084, 2.955]		**2.130*, [0.265, 3.995]**	**0.54**
Depressive symptoms	Smartphone vs. physical activity	0.324, [−1.197, 1.844]		0.199, [−1.186, 1.584]		−0.343, [−1.676, 0.990]	
	Smartphone vs. combination	0.182, [−1.322, 1.685]		0.666, [−0.704, 2.036]		0.532, [−0.786, 1.851]	
	Smartphone vs. control	0.168, [−1.383, 1.718]		−0.713, [−2.125, 0.699]		−0.938, [−2.298, 0.421]	
	Physical activity vs. combination	−0.142, [−1.667, 1.383]		0.467, [−0.923, 1.856]		0.876, [−0.462, 2.213]	
	Physical activity vs. control	−0.156, [−1.727, 1.415]		−0.912, [−2.343, 0.520]		−0.595, [−1.973, 0.783]	
	Combination vs. control	−0.014, [−1.569, 1.542]		−1.378, [−2.795, 0.038]		**−1.470*, [−2.834, −0.107]**	**0.49**
Positive mental health	Smartphone vs. physical activity	0.170, [−1.926, 2.266]		−0.484, [−2.550, 1.581]		0.341, [−1.732, 2.414]	
	Smartphone vs. combination	0.374, [−1.699, 2.448]		−1.102, [−3.146, 0.941]		−0.252, [−2.303, 1.799]	
	Smartphone vs. control	0.209, [−1.929, 2.347]		0.262, [−1.845, 2.369]		1.233, [−0.882, 3.347]	
	Physical activity vs. combination	0.204, [−1.899, 2.307]		−0.618, [−2.691, 1.455]		−0.592, [−2.673, 1.488]	
	Physical activity vs. control	0.039, [−2.127, 2.206]		0.747, [−1.388, 2.882]		0.892, [−1.251, 3.035]	
	Combination vs. control	−0.165, [−2.310, 1.899]		1.365, [−0.749, 0.3.478]		1.484, [−0.637, 3.606]	

(*continued on next page*)

Table 4 (*continued*)

	Groups	Baseline		Post-intervention		Follow-up	
		md, 95%*CI*	d	md, 95%*CI*	d	md, 95%*CI*	d
Sense of control	Smartphone vs. physical activity	−0.082, [−0.815, 0.650]		−0.171, [−0.877, 0.535]		0.490, [−0.167, 1.147]	
	Smartphone vs. combination	0.074, [−0.651, 0.799]		0.386, [−0.313, 1.085]		−0.032, [−0.682, 0.618]	
	Smartphone vs. control	0.187, [−0.560, 0.934]		0.612, [−0.108, 1.332]		**0.848*, [0.178, 1.518]**	**0.58**
	Physical activity vs. combination	0.156, [−0.578, 0.891]		0.557, [−0.151, 1.266]		−0.522, [−1.181, 0.137]	
	Physical activity vs. control	0.269, [−0.488, 1.026]		**0.783*, [0.053, 1.513]**	**0.53**	0.358, [−0.320, 1.037]	
	Combination vs. control	0.113, [−0.637, 0.862]		0.226, [−0.497, 0.948]		**0.880*, [0.208, 1.552]**	**0.62**
Problematic smartphone use	Smartphone vs. physical activity	−0.700, [−4.994, 3.595]		−1.863, [−6.182, 2.456]		−2.787, [−7.004, 1.430]	
	Smartphone vs. combination	0.443, [−3.805, 4.692]		1.807, [−2.465, 6.079]		0.989, [−3.183, 5.160]	
	Smartphone vs. control	0.318, [−4.061, 4.698]		−0.625, [−5.030, 3.780]		−2.866, [−7.166, 1.435]	
	Physical activity vs. combination	1.143, [−3.166, 5.452]		3.670, [−0.663, 8.004]		3.775, [−0.456, 8.007]	
	Physical activity vs. control	1.018, [−3.420, 5.457]		1.238, [−3.226, 5.702]		−0.079, [−4.438, 4.280]	
	Combination vs. control	−0.125, [−4.519, 4.269]		−2.432, [−6.851, 1.987]		−3.854, [−8.169, 0.461]	
Daily non-work-related Smartphone time (in minutes)	Smartphone vs. physical activity	3.395, [−47.167, 53.956]		**−60.538*, [−106.415, −14.660]**	**0.54**	−24.938, [−67.684, 17.809]	
	Smartphone vs. combination	7.688, [−42.329, 57.705]		−9.709, [−55.092, 35.675]		21.605, [−20.681, 63.892]	
	Smartphone vs. control	13.782, [−37.785, 65.349]		**−47.191*, [−93.981, −0.402]**	**0.53**	−25.247, [−68.844, 18.350]	
	Physical activity vs. combination	4.293, [−46.438, 55.025]		**50.829*, [4.797, 96.861]**	**0.44**	**46.543*, [3.652, 89.434]**	**0.48**
	Physical activity vs. control	10.387, [−41.873, 62.648]		13.346, [−34.072, 60.765]		−0.310, [−44.493, 43.874]	
	Combination vs. control	6.094, [−45.640, 57.828]		−37.483, [−84.424, 9.458]		**−46.852*, [−90.590, −3.114]**	**0.54**
Weekly physical activity time (in minutes)	Smartphone vs. physical activity	−8.924, [−59.084, 41.236]		**−132.929*, [−211.574, −54.285]**	**0.84**	−56.357, [−139.511, 26.797]	
	Smartphone vs. combination	−13.062, [−62.682, 36.558]		**−161.553*, [−239.350, −83.755]**	**0.84**	**−100.634*, [−182.893, −18.376]**	**0.64**
	Smartphone vs. control	−6.765, [−57.922, 44.393]		50.218, [−29.990, 130.426]		42.079, [−42.728, 126.887]	
	Physical activity vs. combination	−4.138, [−54.467, 46.191]		−28.623, [−107.532, 50.286]		−44.277, [−127.711, 39.157]	
	Physical activity vs. control	2.159, [−49.686, 54.005]		**183.148*, [101.861, 264.435]**	**0.15**	**98.436*, [12.488, 184.384]**	**0.59**
	Combination vs. control	6.297, [−45.026, 57.620]		**211.771*, [131.303, 292.239]**	**1.10**	**142.714*, [57.632, 227.795]**	**0.76**

Notes. Smartphone Group: $N = 73$, Physical Activity Group: $N = 69$, Combination Group: $N = 72$, Control Group: $N = 64$; Baseline to Follow-up = measurement time points; md = mean difference; *CI*=Confidence Interval; d = Cohen's d, effect-size measure of post-hoc comparisons between groups; pairwise comparisons are Bonferroni-corrected ($p < .050$, two-tailed); significant results are marked in bold. *$p < .050$.

intervention measurement; and it was significantly lower in the combination group than in the physical activity group and the control group at follow-up measurement (small to medium effects; see Table 4).

For weekly physical activity time, the ANOVA indicated a significant main effect for measurement time point, $F(1.93, 528.22) = 62.579$, $p < .001$, $\eta_p^2 = 0.186$ (large effect), a significant main effect for group condition, $F(3, 274) = 13.280$, $p < .001$, $\eta_p^2 = 0.127$, and a significant interaction effect, $F(5.78, 528.22) = 11.424$, $p < .001$, $\eta_p^2 = 0.111$ (large effect). Pairwise comparisons revealed a significant increase of weekly physical activity time between baseline and the other measurements in the smartphone group, and a significant increase between all measurements in the physical activity group and the combination group (small to large effects; see Table 3). It was significantly higher in the physical activity group and the combination group than in the smartphone group and the control group at post-intervention measurement; it was significantly higher in the physical activity group and the combination group than in the control group at follow-up measurement, and in the combination group than in the smartphone group at follow-up measurement (small to large effects; see Table 4).

4. Discussion

We often spend about two thirds of the days of a year at the workplace (SteuerGo, 2024), and we spend each day of the year using our smartphone (Howarth, 2024). Available research showed that there is a significant association between both activities that shape our everyday life (Du et al., 2022; Duke & Montag, 2017). And both are associated with the level of our mental health (Brodersen et al., 2022; Cao et al., 2022; Stanković et al., 2021). Physical activity is a well-known protective factor of mental health that also contributes to work-related outcomes such as work satisfaction (Fang et al., 2019; Wunsch et al., 2017). In the present study, we combined this knowledge in an experimental longitudinal design to assess how employees' work-related and mental health-related outcomes could be protected and improved.

Our results show that a controlled and conscious reduction of time spent daily on non-work-related smartphone use over one week only or in combination with a controlled and conscious enhancement of time spent daily on physical activity could contribute to employees' work-related and mental health-related outcomes. For some variables the combination showed slightly stronger effects than the reduction only. An increase of physical activity showed less promising effects than the other two interventions (see Research Question).

The interventions resulted in a decrease of daily non-work-related smartphone use and an increase of weekly physical activity directly after and up to two weeks after the experimental period. The difference of smartphone use time between baseline and post-intervention was about 67 min in the smartphone group; two weeks later, it was about 41 min; in the combination group, it was about 50 and 55 min; with about 3 and 13 min the difference was not noteworthy in the physical activity group. The increase of physical activity time between baseline and post-intervention was about 61 min in the smartphone group; two weeks later, it was about 54 min; in the combination group, it was about 208 and 140 min; in the physical activity group, it was about 185 and 101 min.

Considering the work-related outcomes, the reduction of smartphone use time and its combination with the enhancement of physical activity contributed to an increase of work satisfaction (confirmation of Hypothesis 1a), work motivation (confirmation of Hypothesis 1b), and work-life balance (confirmation of Hypothesis 1c); the effects were comparable for both interventions. The experience of work overload decreased after both interventions (confirmation of Hypothesis 1d); the effect was stronger for the combination especially in the longer-term. The findings could be explained by the following considerations.

Many people engage in smartphone use while performing other tasks at work and during leisure (David et al., 2018; Whelan & Turel, 2023). Although some persons are good at multi-tasking, for most people, this engagement is accompanied by a decrease in performance in the task at hand (Peifer & Zipp, 2019). Due to a limited attention span, they cannot fully focus on the specific task, their concentration decreases, and they make avoidable mistakes for example because they overlook important details (Dewan, 2014; Wilmer et al., 2017). For the work-related context, this means a decrease in an employees' work quality and/or spending too much time on a specific task (Brooks & Califf, 2017). This can be accompanied by a pressure to meet deadlines, conflicts with employers and co-workers, and a need for overtime hours; overtime hours reduce one's time spent with family and friends (Derks et al., 2021). Persons who experience such kind of stress tend to have irritated and maladaptive reactions in social interactions, which can negatively impact their social life (Augner et al., 2023; Horwood & Anglim, 2021). Those negative experiences can enhance employees' work overload, and reduce their work satisfaction, work motivation, and work-life balance (Gragnano et al., 2020; Pancasila et al., 2020). Moreover, intensive smartphone use at leisure can result in interpersonal conflicts with friends and family that contribute to negative emotions (Busch & McCarthy, 2021). Occupation with negative emotions during working hours can impact one's work quality, enhance the experience of work overload and decrease work satisfaction, work motivation and work-life balance (e.g., Gragnano et al., 2020). To escape the negative emotions and experiences, many people engage in further intensive smartphone use, even though this aggravates the problems in various life areas (Ting & Chen, 2020).

Often, people are unable to break through this circle by their own. They need external support or at least a “nudge” (Busch & McCarthy, 2021). Our controlled intervention could serve as such a “nudge”. Participants had to reduce their smartphone use time. This could contribute to a more conscious use that interferes less with other tasks and social interaction. As a consequence, they could better concentrate on the tasks at hand, and their workflow was less disturbed that resulted in a higher work quality and less stress due to deadlines. They tended to adequate reactions in social interactions and, therefore, experienced fewer interpersonal conflicts at work and home. This could contribute to more positive emotions and reduce the need to search for them by intensive smartphone use (Studer et al., 2022). The requirement to engage in more physical activity could enhance the positive emotions and foster a stress reduction. Those changes could explain the found decrease of work overload, and the increase of work satisfaction, work motivation, and work-life balance.

Our intervention that included an increase of physical activity only did not contribute to an improvement of work-related outcomes (contradiction of Hypothesis 1a to 1d). It seems that changes of smartphone use time are of a higher relevance in the work context than changes of physical activity. This could be an indicator for a negative impact of intensive smartphone use on work-related outcomes. This would emphasize the need to incorporate its conscious and controlled reduction in training programs that aim to improve work satisfaction and performance. But the not significant findings could also mean that certain conditions should be met for physical activity to have a significant positive effect. These conditions may include a greater increase in daily physical activity time than 30 min, a longer intervention period than one week, and changes in other daily habits such as adopting a healthier diet.

Considering mental health-related variables, the reduction of smartphone use time, the increase of physical activity and their combination resulted in a decrease of depressive symptoms (confirmation of Hypothesis 2a). Similar to previous research (Precht et al., 2023), the combination showed the strongest effect. Furthermore, all three interventions contributed to an increase of participants' sense of control (confirmation of Hypothesis 2d). Their effects were comparable high. Our experimental results confirm available literature which described that depressive symptoms are positively associated with smartphone use and negatively with physical activity (Brailovskaia & Margraf, 2023b; Elhai et al., 2018). Sense of control was reported to show an opposite result pattern (Brailovskaia et al., 2021; Keeton et al., 2008). The findings allow for the following considerations. The experience of a lack of control in important areas of everyday life belongs to characteristics of persons with an enhanced level of depressive symptoms (Kvam et al., 2016). To escape negative emotions associated with the lack of control, they often tend to engage in intensive online activity via the smartphone (Yuan et al., 2021). On social media such as TikTok and Instagram, they can decide on their own which content to share and “like” (Cunningham et al., 2021). This provides them with a feeling of regaining some lost control in the short-term (Vally et al., 2023). However, in the longer-term, intensive social media and smartphone use can enhance depressive symptoms and further reduce the sense of control (Brailovskaia & Margraf, 2023a). Following previous research, successful mastering of a specific task can foster a person's sense of control (Southwick & Southwick, 2018). Compliance with the interventions over the one-week period, without reverting to previous smartphone use and physical activity patterns, could provide participants with such a sense of mastery. This could result in an increase in positive emotions and enhance their sense of control. Moreover, the conscious reduction of smartphone use time supported the participants in spending at least one hour daily more outside the online world, reducing the negative effects of online activity. This could contribute to experiences of success at the workplace which could also foster participants' sense of control (Brailovskaia, Becherer, et al., 2023). Engagement in more physical activity could enhance their sense of control by achieving small self-set goals, like increasing own jogging speed, and providing positive emotions while reducing the need to search for them online (Precht et al., 2021). An enhanced sense of control contributes to an employee's self-efficacy that positively contributes to work motivation, work engagement and self-perceived competence (Miller et al., 2017). All those factors are of great importance for the work performance (Pudyaningsih et al., 2020). Thus, the present findings on the improvement of depressive symptoms and sense of control further emphasize the benefits of our interventions in the work context as an addition to established training programs or as a separate program.

Furthermore, the reduction of smartphone use time and its combination with an increase of physical activity time resulted in a decrease of PSU (confirmation of Hypothesis 2b) and in an increase of PMH (confirmation of Hypothesis 2c). The effects of both interventions were comparable strong. A separate increase of physical activity did not show significant changes of PSU and PMH (contradicting Hypothesis 2b and 2c). This emphasizes the importance of a change of smartphone use habits for a protection of employees' mental health. Notably, smartphone use time is a predictor of the addictive tendencies (Brodersen et al., 2022; Busch & McCarthy, 2021). A controlled reduction of the use time could be supportive for people who have already tried to do so but were not successful due to enhanced PSU symptoms, or for persons who were not motivated enough to engage in this step by their own.

PMH is an important protective resource that reduces the negative impact of stressful experiences, contributes to recovery processes in the therapeutic context and decreases the risk for suicide-related outcomes (Brailovskaia et al., 2022; Trompetter et al., 2017). Therefore, an enhancement of the PMH level is an important goal of some time-intensive mental health programs (e.g., Tinoco-Camarena et al., 2022; Westermann et al., 2021). Our findings show that relatively low threshold interventions that focus on smartphone use reduction can provide support in enhancing PMH.

4.1. Practical implications of present findings for the work context

Many organizations engage external coaches that focus on the improvement of employees' work-related and mental health-related outcomes by cost- and time-intensive training programs (Marrone et al., 2022; Wang et al., 2021). The improvement of those variables shell contribute to the organizational commitment and productivity (Ocen et al., 2017; Tabvuma et al., 2015). The present results reveal that a reduction of employees' daily non-work-related smartphone use by one hour over one week can significantly improve work-related and mental health-related outcomes. It can improve work satisfaction itself as well as factors that are of high relevance for it, specifically work motivation, work overload and work-life balance (e.g., Pancasila et al., 2020). Moreover, it contributes to an improvement of mental health (less depressive symptoms, more PMH). Also, sense of control that is a positive predictor of a high mental health level and work productivity (Southwick & Southwick, 2018) increased. In contrast, addictive tendencies of smartphone use that can negatively impact one's mental health and work productivity (Jo et al., 2021) decreased. The combination of a reduction of smartphone use with an increase of physical activity by 30 min daily over one week reinforced some of the positive effects.

Notably, both interventions foster factors that can improve employees' work quality but also their quality of life. They are time- and cost-efficient and can be implemented in one's everyday life without disadvantages for the work process. Against this background, it seems reasonable to incorporate a reduction of employees' daily non-work-related smartphone use and an increase daily of physical activity in business training programs or to consider them as a separate low threshold program. The last one would be of advantage especially for small organizations that cannot bear high training costs without economic losses.

For example, based on the present findings that provide an empirical background, employers can introduce a voluntary reduction of non-work-related smartphone use time by an hour daily and an increase of physical activity by 30 min daily over one or two weeks as a challenge in the organization. Employees should be free in the decision to participate in this challenge and to decide when to include both interventions during their day. Considering that humans are social beings who tend to engage in social comparisons (Wills, 1981), it is likely that employees would participate in such a challenge. The longer they engage in it, the more positive consequences they could experience, such as an improvement of their work satisfaction, work motivation, work-life balance, PMH and sense of control, and a decrease of work overload, depressive symptoms and PSU. The positive experiences could contribute to the formation of new habits, resulting in less smartphone use and more physical activity throughout the employees' day or week, driven by an intrinsic motivation (Carden & Wood, 2018; Gardner & Lally, 2018). This could contribute to a further improvement of the work-related and mental health-related factors and, therefore, the work quality and organizational productivity.

4.2. Limitations and future research

There are some limitations that should be considered when interpreting the present findings. First, our intervention period was seven days only. Future research should replicate the study with a longer intervention period (e.g., two weeks). This could enhance the positive effects and contribute to larger effect sizes. Furthermore, future research should include a longer follow-up period than two weeks (e.g., six months) to assess longer-term effects of the interventions. Earlier studies described that changes in the level of PMH and addictive media use typically require some time to become visible (Brailovskaia, Becherer, et al., 2023; Totzeck et al., 2020). Thus, it could be that we did not find significant differences between groups for PMH and PSU due to the relatively short follow-up period. Future research should test whether potential differences become visible after a longer follow-up period.

Second, our sample was not large enough to identify differences between employees from specific sectors. Future studies should collect larger samples to assess whether specific professional sectors benefit more or less from the interventions. Furthermore, they should assess and control for potential stressors and challenges that could influence the findings, such as holding multiple jobs, job and study simultaneously, parenthood and eldercare (or caring for relatives). Persons who work on a full-time and part-time basis could be compared.

Third, we focused on non-work-related smartphone use time only. To better understand the associations and consequences of smartphone use, future research should assess when the employees engage in the use during work and leisure, and what are the reasons for the use. Previous research on social media showed that persons who use the online world to escape negative emotions are at a higher risk for the development of addictive tendencies than persons who use social media as a source of inspiration (Brailovskaia et al., 2020). Furthermore, future research should assess work-related smartphone use time and its association with work-related and mental health-related outcomes, and whether our three interventions can influence this association.

Fourth, we collected mostly self-report data that are prone to social desirability, distortions of perception, and same-source bias (Conway & Lance, 2010; Musch et al., 2002). Therefore, they should be interpreted with caution. Considering daily non-work-related smartphone use time and weekly physical activity time, we asked our participants to refer to the time tracked by their smartphones, specific applications, or activity trackers. If not available, they estimated the times as accurately as possible. About 80 % of the participants reported tracked smartphone use time and about 35 % reported tracked physical activity time. A comparison of the tracked and estimated time by *t*-tests for independent samples revealed no significant differences. Nevertheless, for a better objectivity and comparability of the findings, it is desirable that all participants install the same tracking application on their smartphone that records the use time and that each participant uses the same physical activity tracker. Also, we had to rely on the participants' honesty considering their working hours and their compliance and could not fully verify it. Furthermore, we communicated with the participants via e-mail only. They were free to contact us anytime they had any questions or issues to clarify considering for example their group task. However, by this approach we could not absolutely ensure that all participants understood the instructions in the same way.

Fifth, it should also be mentioned that between 14.3 % (combination group) and 22.3 % (control group) of the persons who started the investigation dropped out at its different stages. Due to the voluntary and not compensated nature of participation as well as the fact that we did not assess the reasons and motives for participation as well as for the dropouts. Therefore, we cannot exclude a selection bias. It might be that people who considered the investigated topic of specific personal importance or those who were particularly motivated to change their non-work-related smartphone use and/or physical activity were more likely to partake than other people.

Sixth, our participants were relatively young and Caucasian only. This composition limits the representativeness of the results for the general working population. Therefore, our findings should be replicated in more population representative groups. And they should be replicated in other countries than Germany to assess their cross-national generalizability.

5. Conclusions

A high engagement of employees is one of the main predictors of efficacy and productivity of an organization (Shalley et al., 2009). A high level of work satisfaction and mental health is important for the employees' engagement (Bin, 2015; Naz & Sharma, 2017). Our experimental results allow the hypothesis that a reduction of daily time spent on non-work-related smartphone use and its combination with an increase of physical activity could foster employees' work satisfaction, work motivation, and work-life balance, and they decrease the experience of work overload; moreover, the interventions could reduce PSU and depressive symptoms, and they could enhance PMH and sense of control. Against this background, both interventions could be incorporated in the work context without high efforts and without disturbing the work process. This could contribute to cost savings for the organizations and improve employees' life quality. Future experimental longitudinal research should assess the persistence of the positive effects and whether and when booster sessions of the interventions are reasonable.

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Ethics

The study procedures were carried out in accordance with the ethical standards as laid down in the Declaration of Helsinki. The present study was approved by the responsible Ethics Committee in Germany (approval number: 687).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available from the corresponding author on reasonable request.

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