Physical Activity in Women
Effects of a Self-Regulation Intervention

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Background: A physically active lifestyle during midlife is critical to the maintenance of high physical functioning. This study tested whether an intervention that combined information with cognitive–behavioral strategies had a better effect on women's physical activity than an information-only intervention.

Design: A 4-month longitudinal RCT comparing two brief interventions was conducted between July 2003 and September 2004. Analyses were completed in June 2008.

Setting and participants: 256 women aged 30–50 years in a large metropolitan area in Germany.

Intervention: The study compared a health information intervention with an information + self-regulation intervention. All participants received the same information intervention; participants in the information + self-regulation group additionally learned a technique that integrates mental contrasting with implementation intentions.

Main outcome measures: Self-reported minutes of moderate-to-vigorous physical activity per week.

Results: Participants in the information + self-regulation group were twice as physically active (i.e., nearly 1 hour more per week) as participants in the information group. This difference appeared as early as the first week after intervention and was maintained over the course of the 4 months. Participants in the information group slightly increased their baseline physical activity after intervention.

Conclusions: Women who learned a self-regulation technique during an information session were substantially more active than women who participated in only the information session. The self-regulation technique should be tested further as a tool for increasing the impact of interventions on behavioral change.

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Introduction

A physically active lifestyle during midlife is critical to the maintenance of high physical functioning,[1] and mounting evidence shows that physical activity is as important in women as in men in the primary prevention of chronic disease.[2] However, many people find it difficult to change from a sedentary lifestyle to a more active one.[3] How can people change their behavior, and how do interventions help in this process?

Information provides the basis for increasing physical activity. Physician advice alone can be effective in increasing physical activity levels.[4] But information interventions are not sufficient. People must also hold strong intentions to be physically active and then act on these intentions.[5,6] A wealth of studies tested and confirmed this model, known as the theory of planned behavior, for physical activity.[7] But how do strong intentions to be physically active emerge? And, if people hold strong intentions, how do they translate them into action?

Cognitive–behavioral interventions addressing benefits of and barriers to physical activity, self-efficacy, and relapse prevention lead to behavior change.[8–14] In the present research, participants learned a self-regulation technique (mental contrasting with implementation intentions) that uses various components of cognitive–behavioral interventions and puts them into a specific sequence. Mental contrasting facilitates goal commit-

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ment,[15,16] whereas implementation intentions further goal implementation.[17]

In mental contrasting, people (1) name their most important feasible wish that is directed toward changing their behavior (e.g., regular physical activity), (2) name and imagine the most positive outcome of successfully changing their behavior (e.g., being in better shape), and (3) name and imagine the most critical obstacle that stands in the way of wish fulfillment (e.g., being tired after work). If participants expect that they can realize their wish, mental contrasting leads to strong goal commitment. This effect was found in the interpersonal, professional, achievement, and health domains, in different age groups; and for short- and long-term measures of commitment (from immediately after the experiment to 3 months later).[15,16,18]

Even if people have a strong goal commitment, they do not always act on it. Supplementing a goal to which people feel committed (e.g., I intend to be physically active every day!) with an implementation intention that details when, where, and how the person wants to act makes goal realization more probable.[17] Implementation intentions have an if–then format: The if-part specifies a suitable situation in which to act, to which the then-part links a goal-directed response (e.g., If the weather is fine tomorrow morning, then I will bike to work!). A meta-analysis of 94 independent tests[17] found medium-to-large effects of implementation intentions on goal implementation (average effect size: $d = 0.65$). For many health-related behaviors, including physical activity, implementation intentions have shown effects on goal attainment.[19–24]

The combination of mental contrasting and implementation intentions should have a strong impact on behavior change because the two strategies complement each other. Specifically, implementation intentions require strong goal commitment to be effective[25] and mental contrasting creates such commitments.[15,16] Additionally, mental contrasting aids in acknowledging obstacles to behavior change. These obstacles can then be addressed with if–then plans linking the obstacle (in the if-part) with actions to overcome and circumvent the obstacle (in the then-part).

The current study investigated the effectiveness of a self-regulation technique that combined mental contrasting and implementation intentions in increasing physical activity. To decrease variation caused by knowledge differences and to come as close as possible to standard interventions in primary care,[4] all participants received information about regular physical activity and its importance. The study tested the hypothesis that participants who receive an information intervention and also learn the self-regulation technique will be more physically active—both immediately after the intervention and over the 4 months of the study—than participants who receive only the information intervention.

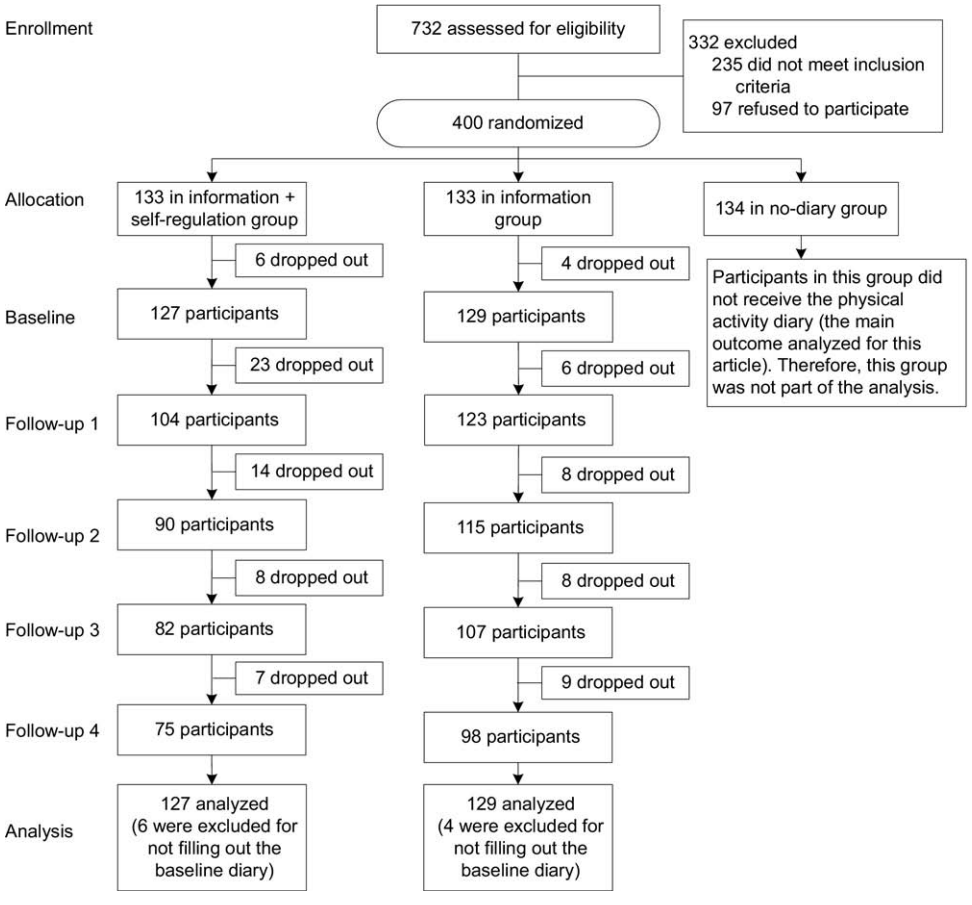

Figure 1. Flow diagram

Methods

Subjects and Setting

A German health insurance association mass-mailed form letters to 10,500 female members aged 30–50 years asking them to participate in a study on healthy lifestyle. The letter conveyed as eligibility criteria that participants have no restrictions on changing their physical activity and diet—to ensure that no medical supervision of behavior change was necessary—and do not participate in similar programs. In response to this letter, 732 women sent back a prepaid postcard asking to receive a screening call (Figure 1). Trained phone inter-

viewers checked eligibility with a standardized interview assessing fluency in German and availability for appointments. Of the interviewed women, 235 were excluded based on the eligibility criteria, and 97 declined to participate. Phone interviewers allocated the remaining women to the groups according to a computer-generated block-randomization list with a block size of three. Of the 400 women randomized, 133 women were allocated to the information + self-regulation group and 133 to the information group; the remaining 134 women were allocated to a no-diary group that did not receive the physical activity diary and therefore are not discussed further. All 266 women received consent forms with a background questionnaire and a baseline diary to record physical activity, accompanied by diary instructions. The 256 women who returned the baseline diary constituted the final sample for the current study (Figure 1).

Design

The study had a single-blind RCT design with a baseline measurement of physical activity before intervention and four follow-up measurements, in the 1st, 4th, 8th, and 16th week after intervention. The Ethics Committee of the Medical Association in Hamburg, Germany approved the study in May 2003; data were collected between July 2003 and September 2004.

Interventions

Both interventions consisted of one meeting of participants with a trained female interventionist in either small groups of two to five women or individually if participants could not attend a group session. Interventionists delivered the scripted intervention based on a manual and on standardized forms for participants.

Information group. The information intervention consisted of three phases: (1) an information phase in which participants studied a health education leaflet detailing the importance of regular physical activity and its immediate and long-term positive effects; (2) a knowledge self-check phase in which participants worked through a multiple-choice test about a healthy lifestyle (with questions such as Which of the activities listed below count as vigorous exercise? Check all that apply—aerobic exercise, volleyball, yoga, . . .); and (3) a discussion phase in which participants compared their own answers with the correct answers provided by the interventionist. Also, participants were encouraged to discuss all questions they might have concerning a healthy lifestyle. Participants received a diary equivalent to the baseline diary to take home and use to record their physical activity.

Information + self-regulation group. In the information + self-regulation group, participants received the same information intervention but also learned the self-regulation technique following a specified sequence. They wrote down four items: (1) their most important current wish regarding physical activity (e.g., biking to work); (2) the most positive outcome of realizing their wish (e.g., getting into better shape) and events and experiences they associated with this positive outcome; (3) the most critical obstacle (e.g., getting up too late) together with events and experiences they associated with this obstacle; and (4) three implementation intentions with the following questions: (1) *When and where does the obstacle occur, and what can I do to overcome or circumvent the obstacle?*; (2) *When and where is an opportunity to prevent the obstacle from occurring, and what can I do to prevent it from occurring?*; and (3) *When and where is a good opportunity for me to act on my wish, and what would this action be?*

For example, a participant could counter the obstacle of getting up too late with the implementation intention *If I get up too late, then I'll skip the morning news!* During the intervention session, participants applied the self-regulation technique four times, twice to a long-term wish for the coming weeks and twice to a short-term wish for the next 24 hours. Finally, participants received the same diary as the information group. The diaries in this group also contained two forms in a designated space on each day's page to be used to practice the self-regulation technique in the four follow-up diaries. Participants were encouraged to practice the self-regulation technique on their own each day, both in writing, using their diary, and mentally throughout the day.

Measures

Physical activity. Participants filled out behavioral diaries for 7 consecutive days at baseline and all 4 follow-up times. The physical activity measure was modeled after the Bouchard Three-Day Physical Activity Record.[26–28] The measure was adapted as follows: First, participants filled out the measure for 7 consecutive days. Second, participants reported moderate-to-vigorous physical activity during leisure time and for transportation for three reasons: (1) the reliability study with the original measure also used higher-intensity physical activity,[26] (2) people report higher-intensity physical activity more accurately than lower-intensity physical activity,[29,30] and (3) behavior change was expected mostly in leisure-time and transportation choices. Physical activity minutes per week were summed. The data were skewed; therefore, they were square-root transformed before data analysis and transformed back to minutes per week for presentation.

Concurrent validity was tested with two correlations: Participants at baseline who reported more physical activity had a lower BMI ($r = -0.14$, $p=0.05$) and a lower percentage of body fat ($r = -0.12$, $p=0.05$). Reliability of summing up each diary's 7 days was determined with a generalizability theory approach[31] (reliability between persons of average physical activity taken over 7 fixed days for the baseline diary: $R_{7F}=0.75$). The first 4 days of the baseline diary correlated with the last 3 days ($r =0.54$, $p<0.001$) indicating acceptable test–retest reliability of the measure.

Baseline characteristics. The background questionnaire asked about age, working status, education, and presence of a partner. Participants also rated three theory-of-planned-behavior scales.[5,6] To measure attitude, participants rated the statement *For me, to be regularly physically active in the next two weeks is . . . (e.g., pleasant–unpleasant)* on six bipolar semantic differential scales (Cronbach's $\alpha=0.85$). Perceived behavioral control was measured with seven items, such as *I am sure that I will keep to my regular physical activity even if I am tired* (1=do not agree at all; 7=fully agree; $\alpha=0.82$). Intention was measured with four items, such as *I intend to be physically active regularly in the coming weeks* (1=do not agree at all; 7=fully agree; $\alpha=0.87$). Before the intervention, weight, height, and body fat composition were measured.

Data Analysis

To verify that randomization yielded exchangeable samples, the groups were compared on background variables. To estimate the intervention effect with an intent-to-treat approach, a mixed-effects model was specified that makes use of all available data, with condition (information + self-regulation group versus information group) as the between-persons factor; follow-up time (1, 4, 8, and 16 weeks after intervention) as the within-persons factor; baseline physical activity as the covariate; and physical activity as the dependent variable. This approach assumes that the missing data are missing at random. Effect sizes for the intervention effect were calculated using the difference in estimated means between the two groups at each follow-up session divided by the pooled SD of physical activity at baseline.

Robustness analyses were conducted in which missing data were estimated with a last-observation-carried-forward approach and also complete-case analyses with listwise deletion of cases with missing data. The effect of the interventions from baseline to Follow-up 1 was determined with separate *t* tests for each experimental group. To analyze attrition, frequencies of retained and lost participants in the two groups were compared separately for each follow-up session with chi-square tests. Retained and lost participants in both groups at each time point were compared on baseline characteristics. All analyses were conducted using SPSS (version 15.0); data analysis was completed in June 2008.

Results

Sample Characteristics and Randomization

Sample characteristics at baseline are shown in Table 1. More than one third of participants did not exercise at all (40.2% of the sample). Participants in both groups reported intention, attitude, and perceived behavioral control close to the high end of the scale. Therefore, the social–cognitive preconditions[5,6] for effects of the interventions were met in both groups. There were no baseline differences between the two randomized groups. Figure 1 shows the flow of participants through the study.

Effects of the Intervention

The mixed-effects model showed an effect of condition ($F[1,204] = 18.92$, $p<0.001$) indicating that participants in the information + self-regulation group were more physically active than participants in the information group (Table 2). Both the main effect of time and the interaction effect of time and condition were nonsignificant ($F[3,324] \leq 0.57$, $p \geq 0.64$). This is consistent with the conclusion that participants in the whole sample as well as in both groups maintained the level of physical activity that they attained immediately after intervention over the 4 months of the study. Baseline physical activity predicted follow-up physical activity ($F[1,209] = 101.63$, $p<0.001$). Effects of condition were medium-sized, d=0.43, 0.47, 0.53, and 0.47 at Follow-up 1, 2, 3, and 4, respectively. Additional analyses with models including all two- and three-fold interactions of baseline physical activity with time and condition yielded nonsignificant results.

Robustness analyses yielded the same pattern of results. Participants in the information + self-regulation group

Table 1. Sample characteristics at baseline for all participants and by intervention group

Variables	All $n=256$[a]	Information + self-regulation group $n=127$	Information group $n=129$	Group differences p value
Age (years)				
M (SD)	41.28 (6.19)	41.33 (5.91)	41.22 (6.48)	0.891
Working status (%)				
Employed full time	51.8	53.2	50.4	
Employed part time	30.8	32.3	29.5	0.493
Not in paid job	17.4	14.5	20.2	
Partner (%)				
With partner	73.2	74.8	71.7	0.575
Highest education level (%)				
≤10 years of school	44.5	43.2	45.7	0.684
BMI (%)				
<25	57.4	53.5	61.2	
25–29	31.3	33.9	28.7	0.457
≥30	11.3	12.6	10.1	
Body fat				
M % (SD)	29.49 (6.45)	30.12 (6.48)	28.88 (6.40)	0.132
Baseline physical activity				
Mean minutes per week (SD)	41.57 (45.03)	45.52 (53.29)	37.87 (37.07)	0.481
Sedentary participants (%)	40.2	40.2	40.3	0.980
Theory of planned behavior				
Mean intention (SD)	5.89 (1.06)	5.84 (1.13)	5.93 (0.98)	0.465
Mean attitude (SD)	6.05 (0.86)	6.06 (0.88)	6.05 (0.85)	0.978
Mean perceived behavioral control (SD)	5.01 (1.11)	5.02 (1.20)	5.01 (1.03)	0.967

[a]Baseline data missing for working status=3, partner=6, highest education level=2, body fat=1

Table 2. Physical activity level (in minutes per week) for information + self-regulation group and information group over 4 months, controlling for baseline physical activity

	Information + self-regulation group	Information group
Time points	**M (CI)**	**M (CI)**
Baseline	45.52 (29.86, 64.46)	37.87 (25.94, 52.04)
1 week after intervention	102.86 (81.60, 126.59)	55.50 (41.37, 71.71)
4 weeks after intervention	110.57 (83.61, 141.28)	58.37 (41.08, 78.69)
8 weeks after intervention	104.18 (77.46, 134.86)	49.34 (33.25, 68.61)
16 weeks after intervention	96.06 (69.61, 126.79)	49.08 (32.72, 68.76)

Note: The table shows model-based estimated means and a 95% CI. All values were computed with a model using the square root of physical activity minutes per week; the results were transformed back into minutes per week for presentation.

held their initial increase in physical activity immediately after the intervention over the following 4 months, whereas participants in the information group remained at their lower level over the course of the study. To determine the immediate effect of the information + self-regulation intervention on physical activity from baseline to Follow-up 1, separate t tests were conducted for each experimental group. These tests revealed a pronounced increase of more than 60 minutes per week in the information + self-regulation group (at baseline: M=46.24; at Follow-up 1: M=107.12; $t[101]=5.00$, $p<0.001$), whereas participants in the information group showed an increase of about 15 minutes per week (at baseline: M=40.20; at Follow-up 1: M=55.50; $t[120]=2.04$, $p=0.04$).

Attrition Analysis

To examine potential bias introduced by differential attrition between groups (Figure 1), frequencies of retained and lost participants in the two groups were compared separately for each follow-up wave. Women in the information + self-regulation group were more likely to drop out at Follow-up 1: $\chi^2(1)=11.54$, $p<0.001$, and at Follow-up 2: $\chi^2(1)=3.12$, $p=0.08$, whereas there were no differences at Follow-up 3 and 4: $\chi^2(1)\leq 0.26$, $p\geq 0.61$. Analyses to detect differential attrition showed no differences between retained and lost participants in either group on any of the sample characteristics listed in Table 1 at Follow-up 1 and 3.

For Follow-up 2, two variables showed main effects for attrition: age ($F[1,223]=3.81$, $p=0.05$), and perceived behavioral control ($F[1,223]=4.32$, $p=0.04$). Participants retained in the study compared with participants lost at Follow-up 2 were older (M=41.38 vs 38.41) and higher on perceived behavioral control (M=5.08 vs 4.53). For Follow-up 4, retained and lost participants did not differ in the two groups except for BMI; women with higher BMI in both groups were less likely than women with normal weight to participate at Follow-up 4 (OR=0.33, $p=0.02$). The attrition analyses had limited power to detect differences between lost and retained participants; the differences detected indicate that the effects of the intervention cannot be attributed to differential attrition.

Discussion

This study tested the effectiveness of a self-regulation technique for facilitating behavior change. Participants in the information + self-regulation group were twice as physically active as participants in the information group—with nearly 1 hour more physical activity per week. The effect of the self-regulation technique on physical activity set in immediately after the intervention and remained stable after 4, 8, and 16 weeks. Participants in both groups had high intentions to be physically active backed up by positive attitude and high perceived behavioral control. But only participants in the information + self-regulation group turned these favorable preconditions for behavior change into an immediate and lasting increase in physical activity; participants in the information group showed only a slight increase in physical activity.

Some limitations of the current study should be noted. First, the main outcome of the study—self-reported physical activity—is prone to measurement error.[30] Studies with objective measures of physical activity are needed to complement the available data on reliability and validity of the measure. Second, it is a concern that attrition might have introduced bias. More participants were retained in the information group than in the information + self-regulation group at Follow-up 1, and as a tendency, at Follow-up 2. There were no differences found at Follow-up 1 and 3 between retained and lost participants in the two groups. At Follow-up 2 and 4, retained and lost participants showed the same differences in both groups. This indicates that bias introduced by differential attrition was limited. Third, one might argue that participants in this study were more motivated than those in other samples. However, the results should generalize to the general population and patient samples because, as with other critical samples, many participants in the present study were sedentary at baseline. In addition, the effectiveness of mental contrasting and implementation intentions was observed in many different samples.[15–17]

Some preparedness for change is required to attain lasting increases in physical activity. The self-regulation technique relies on two preconditions: (1) People need to expect that they can adopt a particular physical activity. (2) They need to be able to name and imagine a positive outcome of successfully changing this physical activity. All participants in the current study were able to identify such a wish that fulfilled these two

preconditions (e.g., to regularly go for a brisk walk during lunch break or use a stationary bike at home three times a week). If people do not meet these minimal preconditions, it is advisable to first create these preconditions with other intervention components.[8–14,20,21,32] Only then should the self-regulation technique be applied. Certainly, individual success is greatly facilitated if the environment and policy are conducive to physical activity and thus produce favorable preconditions.[8,32–34]

In conclusion, this study provides evidence that cognitive–behavioral strategies help women be more physically active. The self-regulation technique—mental contrasting with implementation intentions—was effective for initiating and maintaining behavior change. It is a low-cost intervention component that requires only a single session to learn the technique. People can then apply the technique on their own. The self-regulation technique should be tested further as a tool for short- and long-term change in physical activity and other behaviors.

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