# The positive effect on determinants of physical activity of a tailored, general practice-based physical activity intervention

E. M. F. Van Sluijs[1], M. N. M. Van Poppel[1,2,5], J. W. R. Twisk[3],
J. Brug[4] and W. Van Mechelen[1,2]

## Abstract

**PACE (Physician-based Assessment and Counseling for Exercise) is an individualized theory-based minimal intervention strategy aimed at the enhancement of regular physical activity. The aim of this study was to evaluate the effectiveness of a PACE intervention applied by general practitioners (GPs) on potential determinants of physical activity. A randomized controlled trial was conducted in 29 general practices with the following inclusion criteria for patients: aged between 18 and 70 years, diagnosed with hypertension, hypercholesterolemia and/or non-insulin-dependent diabetes mellitus, and not in maintenance stage for regular physical activity. The intervention consisted of two visits with the GP and two telephone booster calls by a physical activity counselor. Determinants of physical activity were assessed with questionnaires at baseline, and at 8-week (short), 6-month (medium) and 1-year (long) follow-up. A significant positive effect was observed on self-efficacy, and on the use of cognitive and behavioral processes of change, at both short- and medium-term follow-up. The intervention respondents also perceived fewer barriers for regular physical activity at short-term and used behavioral processes of change more at long-term follow-up. No intervention effect was observed for perceived benefits of physical activity. In conclusion, this GP-based PACE intervention resulted in positive changes in potential determinants of physical activity.**

## Introduction

The benefits of regular physical activity have been well documented in the previous decade (Lee *et al.*, 2000; Boutron-Ruault *et al.*, 2001; Wannamethee and Shaper, 2001; Oguma *et al.*, 2002). On the other hand, in this same decade, studies have reported on the alarmingly decreasing levels of physical activity in Western countries (Pate *et al.*, 1995; CDC, 2001). In order to stop or reverse this negative trend various interventions have been developed in different settings and populations, and based on different theories.

The PACE (Physician-based Assessment and Counseling for Exercise) intervention is a physical activity promotion intervention based on Social Cognitive Theory (SCT) (Bandura, 1986) and the Transtheoretical Model (TTM) (Prochaska and DiClemente, 1983), and was originally developed for use in primary care in the US (Calfas *et al.*, 1996). The PACE intervention aims at changing physical activity behavior through changing several psychosocial factors that are determinants of health behavior change according to SCT and the TTM.

[1]Department of Social Medicine and Institute for Research in Extramural Medicine, [2]Body@Work, Research Center Physical Activity, Work and Health TNO-VUmc and [3]Department of Clinical Epidemiology and Biostatistics and Institute for Research in Extramural Medicine, VU University Medical Center, Van der Boechorststraat 7, 1081 BT Amsterdam and [4]Department of Public Health, Erasmus University Medical Center, Postbus 1738, 3000 DR Rotterdam, The Netherlands
[5]Correspondence to: M. N. M. van Poppel;
E-mail: mnm.vanpoppel@vumc.nl

The main goals with respect to these determinants are (A) enhancing self-efficacy regarding participation in physical activity, (B) promoting social support for physical activity, (C) influencing the decisional balance and (D) applying the processes of change as mediators of change. The first two goals (A and B) are derived from the SCT, whereas the last two goals (C and D) can be attributed to the TTM. PACE was proven to be acceptable and feasible in a primary care setting (Long *et al.*, 1996). Furthermore, outcome evaluations showed a positive short-term effect of PACE on both the determinants of physical activity behavior and on patients' level of physical activity (Calfas *et al.*, 1996, 1997).

Several authors have argued that it is important not only to evaluate the effect of the behavior change intervention at a behavioral level, but also at the level of the targeted determinants (Baranowski *et al.*, 1997; Calfas *et al.*, 1997; Sallis *et al.*, 1999; Lewis *et al.*, 2002), as these are hypothesized to mediate the targeted behavior change. Knowledge on the change at the level of determinants can provide insight in the dynamics of changing behavior. A recent literature review, however, only identified 10 papers describing the effect on determinants in adult-targeted physical activity interventions (Lewis *et al.*, 2002). The effects of the interventions on most determinants were mixed, with the most consistent positive results for the behavioral processes of change. Only few studies described the effects on determinants at long-term follow-up, at multiple follow-ups or as a result of a primary care-based intervention. Of the two studies reporting on long-term follow-up (Nichols *et al.*, 2000; Pinto *et al.*, 2001), only one showed long-term positive results in favor of the intervention group on both processes of change and social support (Nichols *et al.*, 2000). Furthermore, two studies were included evaluating primary care-based interventions (Calfas *et al.*, 1997; Pinto *et al.*, 2001). Both studies reported positive short-term effects on both processes of change, whereas only one study showed additional positive effects on self-efficacy and on the decisional balance (Pinto *et al.*, 2001).

The aim of the present study is to evaluate the short-, medium- and long-term effectiveness of a theory-based physical activity intervention, PACE, applied in Dutch general practices (GPs), on changes in determinants of physical activity.

## Methods

### Study design and study population

A randomized controlled trial was conducted in 29 volunteering GPs located throughout the Netherlands, including both rural and city practices. No criteria were set for the inclusion of the GPs. The inclusion criteria for patients were (1) being diagnosed with hypertension and/or hypercholesterolemia and/or non-insulin-dependent diabetes mellitus (NIDDM), (2) aged between 18 and 70 years, (3) physically able to be at least moderately physically active, and (4) not being in the maintenance stage for regular physical activity. Based on these inclusion criteria, each GP identified a target population, of which the research team randomly selected 90 patients. If the target population included less than 90 patients, all patients were selected. These patients received an invitation letter signed by the GP and an additional leaflet with more detailed study information. Patients could indicate whether they were willing to participate in the study by sending a stamped addressed recruitment reply card on which four questions were answered to check the inclusion criteria. These questions addressed physical activity behavior in the past 6 months, the perceived ability to be moderately physically active and availability for the study period. With those, eligibility was checked at the research centre and all patients received information on whether or not they were included in the study. It was concluded from a previously conducted pilot study that approximately one-third of the contacted patients would be willing and eligible to participate in the study. Approximately 25 patients per practice (range 13–31) were included during the inclusion period (October 2001–July 2002).

Randomization to the intervention or control condition was performed at GP level, in order to

minimize contamination. GPs located in the same health care centre were considered separate units of randomization. Multiple providers (GP or practice nurse) within one practice, however, were allocated to the same condition. Randomization was stratified by the main providers' own level of physical activity (i.e. whether or not meeting the ACSM/CDC physical activity guideline of performing at least moderate intensity physical activity for at least 30 minutes per day on 5 and preferably on all days of the week). Computer-generated blocks of four GPs per strata were used. GPs were informed on the outcome of the randomization after the patient selection, in order to rule out selection bias. Next, in order to determine a possible measurement effect, subjects were randomized individually to a group participating in four measurements (baseline and follow-up measurements at 8 weeks, 6 months and 1 year) or to a group participating in only two measurements (at 6-month and 1-year follow-up). Patients were neither informed on the unit of both randomizations nor on the outcome of the randomizations. Only the data from the subjects randomized to the four measurement groups are used for this paper. Written informed consent was collected from all participating patients. The Medical Ethical Committee of the VU University Medical Center approved the study protocol.

## Intervention

All patients visited their provider at baseline for a 10-minute consultation, irrespective of their randomization. In addition to discussing the specific medical condition of the patient (hypertension, hypercholesterolemia or NIDDM), the provider also advised the patient on becoming more physically active. In the intervention condition, the provider used the PACE physical activity program. The PACE materials and the main intervention components are described in detail elsewhere (Calfas *et al.*, 1996; Long *et al.*, 1996; Van Sluijs *et al.*, 2004). In short, the intervention consisted of two visits with the provider and two booster telephone calls with a PACE physical activity counselor. At the first visit to the GP, patients filled out a stage-assessment form and one of three counseling protocols tailored to the patient's stages of change (either the precontemplation, contemplation/preparation or action/maintenance protocol). Each protocol contained stage-specific information and questions which the patient was asked to answer prior to the visit with the provider. During the visit, the provider reviewed the protocol, counseled the patient by emphasizing stage-specific issues, gave positive feedback and summarized a physical activity prescription on the protocol. The provider finally filled out a registration form for administration. A booster telephone call was performed 2 weeks after the initial visit, in order to encourage the patient to continue changing the behavior in the positive direction and to discuss possible problems or questions raised. During the follow-up consultation with the provider 4 weeks after the initial visit, the stage of change was assessed once again. However, a new counseling protocol was only handed to those patients who had progressed or regressed through the stages. During the consultation, the provider reviewed the registration form (and possibly a new counseling protocol) and discussed progression. A final booster telephone call followed 8 weeks after this second visit, mainly aimed at relapse prevention.

Intervention providers received a manual and were trained in a 1-hour individual training session. The main aims of the training were increasing the knowledge of physical activity, health and behavior change, introducing and practicing with the PACE materials, and answering questions. Providers were contacted after their first PACE consultations to discuss any problems or questions raised. The intervention practice assistants were trained in the intervention and research procedures in a half-hour individual training session.

Providers in the control condition were asked to discuss the patient's current level of physical activity and, when appropriate, to stimulate the patient to become more physically active. A standard example text on physical activity promotion to say to the patient was provided.

## Measurements

All outcome measures were assessed with questionnaires. All subjects were asked to fill out the

questionnaires at baseline (prior to the first visit with the provider, T0), and at 8-week (T1), 6-month (T2) and 1-year (T3) follow-up. At baseline, the practice assistants in the participating GPs collected the questionnaires. At 8-week follow-up the subjects returned the questionnaire by mail. At 6-month and 1-year follow-up the subjects were invited to bring their completed questionnaire to a visit in their GP, where research assistants were present. At 6 months, the research assistants also asked the subjects to indicate to which condition they thought they were randomized (i.e. control or PACE). Subjects who did not show up at this measurement were encouraged to return their completed questionnaire by mail. Subjects not returning the questionnaire at a particular follow-up measurement, but who did not withdraw from the study, were considered 'not available' for that particular measurement and were contacted again for the next follow-up measurement.

## Outcome measures

- *Self-efficacy*. Self-efficacy in two subscales (making time and resisting relapse) was assessed with a 12-item scale (six items per subscale) (Sallis *et al.*, 1988). Subjects were asked to indicate how confident they were that they could be physically active in a variety of situations (e.g. 'making time for my physical activity program').
- *Benefits of physical activity*. Perceived benefits of physical activity are a component of the decisional balance. They were assessed with a 14-item scale in which subjects could rate their agreement with positive statements about the possible effects of regular physical activity (e.g. 'If I participate in regular physical activity, I will feel less stressed') (Sallis *et al.*, 1989).
- *Barriers to physical activity*. The counter-component in the decisional balance, barriers to physical activity, were measured with a 24-item questionnaire in which subjects could indicate how often the mentioned barriers prevented them from becoming physically active (Sallis *et al.*, 1989).
- *Social support*. Social support for exercise was measured separately for family and friends

(Sallis *et al.*, 1987). The subject rated the frequency (0 = never, 4 = very often) of with which family or friends supported them in 13 situations (e.g. '...did physical activities with me').
- *Processes of change*. The processes of change were measured with the 20-item version of the Processes of Change Questionnaire (Marcus *et al.*, 1992). Subjects were asked to rate the frequency of occurrence of given situations or experiences related to physical activity in the past month. Processes were categorized into two main categories: cognitive/experiential processes (including consciousness raising, dramatic relief, environmental re-evaluation, self-re-evaluation and social liberation) and behavioral processes (including counter conditioning, helping relationships, reinforcement management, self-liberation and stimulus control).

Reliable and valid questionnaires were used for all outcome measures (Sallis *et al.*, 1987, 1988, 1989; Marcus *et al.*, 1992) and all items were measured on a five-point Likert scale. To assess a score for an outcome measure, the total number of points scored was divided by the number of items answered. For all outcome measures, a rule was applied that 75% of the items had to be answered to be able to estimate a meaningful average. Overall, higher scores indicate higher self-efficacy, more perceived benefits, more perceived barriers, more social support and more use of the processes of change.

## Data analysis

To test for differences in level of physical activity, age, level of education, smoking and gender distribution at baseline between intervention and control group, $\chi^2$-tests and an independent samples *t*-test (age) were conducted. Because of randomization at GP level, linear multilevel regression analysis (Goldstein, 1995) with two levels (i.e. individual and practice) was used to estimate the effect of the intervention. For all outcome measures, baseline values were used as covariate. Two analyses were performed for all outcome measures at all follow-up measurements—one crude analysis and one

adjusted, in which the following covariates were added: gender, age, education (high, medium, low), employment [full-time, part-time (less than 36 hours per week), not employed], children in household [none, younger children, adolescents (over 12 years)], smoking (yes/no) and baseline physical activity [whether or not meeting the ACSM/CDC guideline for regular physical activity, which was assessed with the validated SQUASH questionnaire (Wendel-Vos *et al.*, 2003)]. Furthermore, possible effect modification was analyzed for the following variables: baseline physical activity (dichotomous), smoking, gender and age. Subgroup analyses for all follow-ups were performed in cases where significant effect modification ($P < 0.10$ for the interaction term) was detected. All analyses were on an intention-to-treat basis and variability in the number of subjects in the analysis is due to incomplete data sets.

## Results

### Study population

Of 2377 invited patients, 1396 (59%) returned the recruitment reply card. Of these responders, 238 (17%) refused to participate and 387 (28%) were excluded for various reasons (see Figure 1). After group allocation at GP level and individual randomization for the number of measurements, 191 subjects were randomized to the intervention four-measurement condition and 205 subjects to the control four-measurement condition. Of this total group of 396 subjects, 358 (90.4%) were available for the baseline measurement and were included in the study (T0). At 8-week follow-up (T1), 335 (93.6% of 358) subjects returned their questionnaire. The follow-up rates at 6-month (T2) and 1-year (T3) follow-up were 89.4 and 86.3%, respectively (a respective total of 320 and 309 subjects). The flow of subjects and the distribution of non-responders are shown in Figure 1.

Table I shows descriptive data of the total study population at baseline. The mean age of the subjects was 55.5 years; 50.8% was male and most subjects had a medium level of education. No statistically significant differences between the two study groups were observed for the demographic variables. However, significantly more subjects in the control condition were active according the CDC/ACSM guideline for regular physical activity (49.2 versus 38.2%). When asked at 6-month follow-up, most subjects in both the intervention and the control condition thought that they were randomized to the control condition (76.3 and 70.1%, respectively).

### Main effects

Table II shows the uncorrected means for all outcome measures at baseline and the three follow-up measurements. As shown in Table III, a statistically significant positive effect of the intervention was found for both self-efficacy subscales (e.g. 'making time for exercise' and 'resisting relapse') at the 8-week (T1) and 6-month (T2) follow-up. No difference between the control and intervention condition was found at 1-year follow-up for both self-efficacy subscales. No changes in perceived benefits of physical activity were observed as a result of the intervention. A significant decrease of perceived barriers was observed at short-term follow-up (8 weeks), and a small and non-significant decrease was observed at 6-month follow-up. A significant positive intervention effect on the behavioral processes of change was observed at all follow-ups. Besides this, a statistically significant effect on the cognitive processes of change was observed at T1 and T2. Results of both the social support subscales were considered unreliable, as only a small percentage of the subjects completed the social support-questionnaire (percentages ranged from 38.0 to 70.9% for all follow-up measurements) and a number of subjects filled out the same answer for all items. No analyses were performed on these data. The correction for potential confounders did not lead to substantial changes in the results of any of the analyses and the same conclusions were drawn from both analyses.

### Subgroup analyses

Only a few significant interactions were assessed. The results of the corresponding subgroup analyses
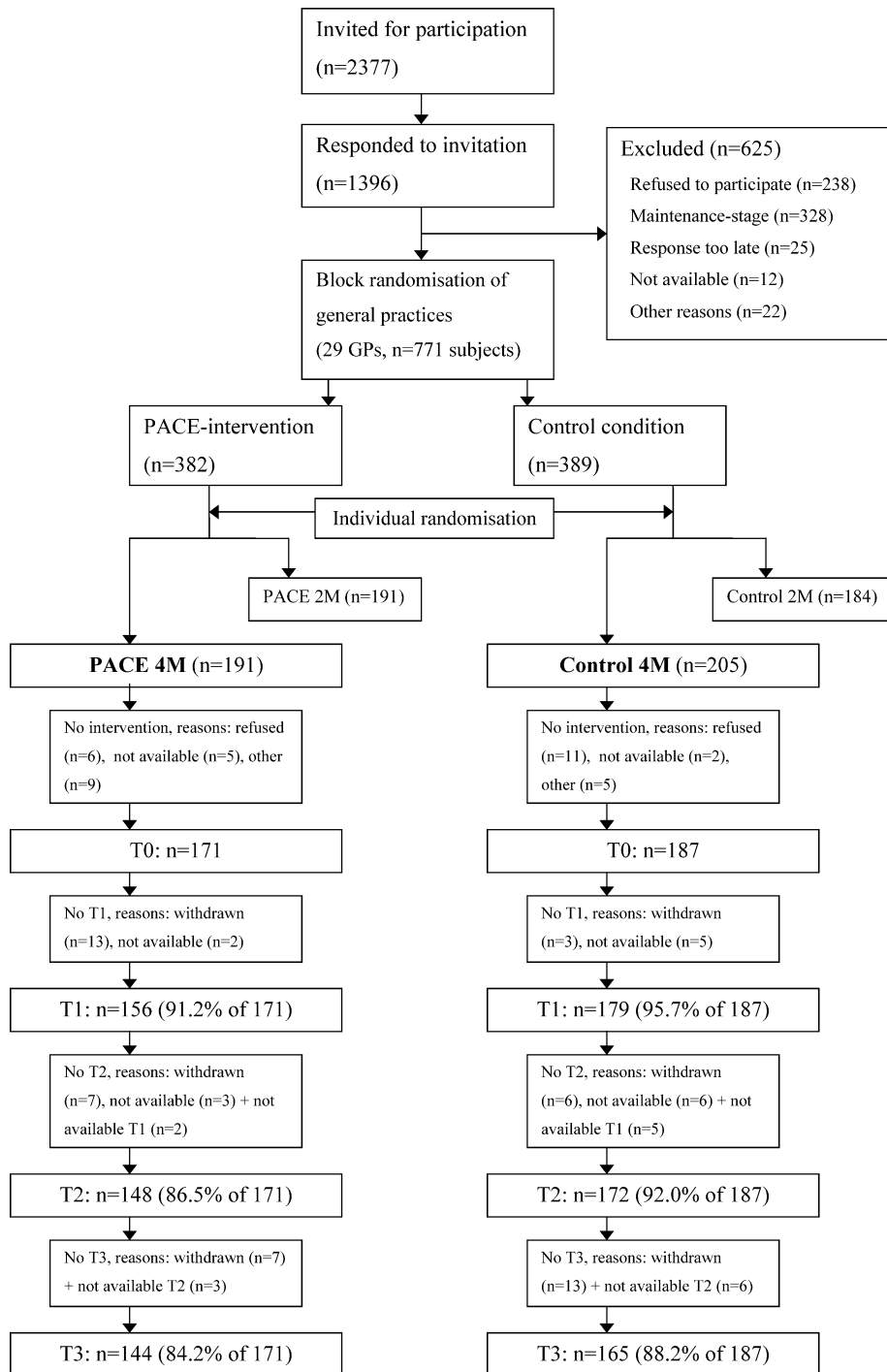
```
┌─────────────────────────────┐
│ Invited for participation   │
│ (n=2377)                    │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐         ┌──────────────────────────────────┐
│ Responded to invitation     │         │ Excluded (n=625)                 │
│ (n=1396)                    │────────▶│   Refused to participate (n=238) │
└─────────────────────────────┘         │   Maintenance-stage (n=328)      │
              │                         │   Response too late (n=25)       │
              │                         │   Not available (n=12)           │
              ▼                         │   Other reasons (n=22)           │
┌─────────────────────────────┐         └──────────────────────────────────┘
│ Block randomisation of      │
│ general practices           │
│ (29 GPs, n=771 subjects)    │
└─────────────────────────────┘
         │              │
         ▼              ▼
┌──────────────────┐  ┌──────────────────┐
│ PACE-intervention│  │ Control condition│
│ (n=382)          │  │ (n=389)          │
└──────────────────┘  └──────────────────┘
```

|                  | Individual randomisation |                      |
|------------------|--------------------------|----------------------|
| PACE 2M (n=191)  |                          | Control 2M (n=184)   |

| **PACE 4M** (n=191) | **Control 4M** (n=205) |
|---|---|
| No intervention, reasons: refused (n=6), not available (n=5), other (n=9) | No intervention, reasons: refused (n=11), not available (n=2), other (n=5) |
| T0: n=171 | T0: n=187 |
| No T1, reasons: withdrawn (n=13), not available (n=2) | No T1, reasons: withdrawn (n=3), not available (n=5) |
| T1: n=156 (91.2% of 171) | T1: n=179 (95.7% of 187) |
| No T2, reasons: withdrawn (n=7), not available (n=3) + not available T1 (n=2) | No T2, reasons: withdrawn (n=6), not available (n=6) + not available T1 (n=5) |
| T2: n=148 (86.5% of 171) | T2: n=172 (92.0% of 187) |
| No T3, reasons: withdrawn (n=7) + not available T2 (n=3) | No T3, reasons: withdrawn (n=13) + not available T2 (n=6) |
| T3: n=144 (84.2% of 171) | T3: n=165 (88.2% of 187) |

**Table I.** *Characteristics of the total study group at baseline*

|  | Control ($N$ = 187) | PACE intervention ($N$ = 171) | Total ($N$ = 358) |
|---|---|---|---|
| Age [mean (SD)] (years) | 55.3 (9.8) | 55.7 (9.1) | 55.5 (9.5) |
| Gender (% male) | 54.5 | 46.8 | 50.8 |
| Level of education |  |  |  |
| low | 70/184 (38.0%) | 57/164 (34.8%) | 127/348 (36.5%) |
| medium | 76/184 (41.3%) | 74/164 (45.1%) | 150/348 (43.1%) |
| high | 38/184 (20.7%) | 33/164 (20.1%) | 71/348 (20.4%) |
| Physically active?[a],* |  |  |  |
| yes (active) | 91/185 (49.2%) | 65/170 (38.2%) | 156/355 (43.9%) |
| no (inactive) | 94/185 (50.8%) | 105/170 (61.8%) | 199/355 (56.1%) |
| Current smoker (yes)[b] | 42/184 (22.8%) | 46/171 (26.9%) | 88/355 (24.8%) |

*$P < 0.05$.
[a]Performing at least moderate-intensity physical activity for at least 30 minutes per day on at least 5 days of the week at baseline (ACSM/CDC physical activity guideline): yes/no. Missing values for three subjects.
[b]Missing values for three subjects.

**Table II.** *Uncorrected means (SDs) for all outcome measures at baseline (T0), 8 weeks (T1), 6 months (T2) and 1 year (T3) for subjects in the control condition and in the intervention condition*

| Outcome measure | Control condition | | | | Intervention condition | | | |
|---|---|---|---|---|---|---|---|---|
|  | T0 | T1 | T2 | T3 | T0 | T1 | T2 | T3 |
| Self-efficacy, subscales |  |  |  |  |  |  |  |  |
| making time | 2.11 (0.92) | 2.00 (0.96) | 2.01 (1.06) | 2.18 (0.97) | 2.07 (0.99) | 2.23 (0.98) | 2.30 (1.00) | 2.21 (1.03) |
| resisting relapse | 2.30 (1.04) | 2.14 (1.08) | 2.11 (1.06) | 2.23 (1.06) | 2.15 (1.04) | 2.37 (0.93) | 2.37 (0.99) | 2.23 (0.95) |
| Perceived benefits | 2.58 (0.51) | 2.57 (0.57) | 2.52 (0.66) | 2.59 (0.49) | 2.55 (0.65) | 2.60 (0.66) | 2.55 (0.60) | 2.59 (0.55) |
| Barriers | 1.19 (0.58) | 1.18 (0.61) | 1.12 (0.59) | 1.10 (0.54) | 1.16 (0.59) | 1.07 (0.56) | 1.04 (0.52) | 1.11 (0.59) |
| Processes of change |  |  |  |  |  |  |  |  |
| cognitive/experiential | 1.32 (0.64) | 1.27 (0.65) | 1.27 (0.67) | 1.33 (0.66) | 1.26 (0.62) | 1.40 (0.71) | 1.38 (0.68) | 1.36 (0.67) |
| behavioral | 1.20 (0.56) | 1.22 (0.61) | 1.18 (0.60) | 1.29 (0.60) | 1.17 (0.62) | 1.39 (0.70) | 1.39 (0.71) | 1.37 (0.65) |

Range of possible scores for all outcome measures: 0–4.

are shown in Table IV. The effect of the intervention on the self-efficacy subscale 'resisting relapse' was different for the 'inactives' and 'actives'. A statistically significant effect at all follow-ups was observed for the 'inactives', whereas no effect was observed for the 'actives'. This difference in effect only was statistically significant at the 1-year follow-up (T3). With respect to perceived barriers, the intervention effect differed significantly at 1-year follow-up (T3) between the smokers and non-smokers, although the effect was non-significant in both groups. Separate analysis for smokers and non-smokers at the other follow-up measurements showed that the smokers decreased in perceived barriers at 8-week follow-up (T1), whereas no effect was observed for the non-smokers. However, this difference in effect was not

**Fig. 1.** Flow of subjects in randomized controlled trial. PACE 4M, PACE intervention condition with measurements at baseline, eight weeks, six months, and one year; PACE 2M, PACE intervention condition with measurement at six months, and one year; Control 4M, control condition with measurements at baseline, eight weeks, six months, and one year; Control 2M, control condition with measurement at six months, and one year; Not available, subject did not return questionnaire at follow-up measurement, but was contacted for the next measurement(s).

E. M. F. Van Sluijs *et al.*

**Table III.** *Results of linear regression analysis regarding the main effects of the PACE-intervention on determinants of physical activity at 8 weeks (T1), 6 months (T2) and 1 year (T3)*

| Outcome measure | T1 | | | T2 | | | T3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | *N* | β (95%CI) | *P* | *N* | β (95%CI) | *P* | *N* | β (95%CI) | *P* |
| Self-efficacy, making time | | | | | | | | | |
| crude model | 307 | 0.29 (0.14; 0.44) | <0.001*** | 298 | 0.28 (0.10; 0.46) | <0.01** | 280 | 0.06 (−0.12; 0.25) | NS |
| corrected model | 289 | 0.29 (0.13; 0.45) | <0.001*** | 283 | 0.28 (0.10; 0.47) | <0.01** | 278 | 0.09 (−0.10; 0.27) | NS |
| Self-efficacy, resisting relapse | | | | | | | | | |
| crude model | 301 | 0.33 (0.15; 0.51) | <0.001*** | 290 | 0.31 (0.12; 0.49) | <0.001*** | 276 | 0.12 (−0.07; 0.32) | NS |
| corrected model | 284 | 0.35 (0.17; 0.53) | <0.001*** | 275 | 0.35 (0.15; 0.55) | <0.001*** | 263 | 0.14 (−0.06; 0.34) | NS |
| Barriers | | | | | | | | | |
| crude model | 301 | −0.10 (−0.19; −0.02) | <0.01** | 293 | −0.06 (−0.14; 0.03) | NS | 278 | 0.00 (−0.08; 0.08) | NS |
| corrected model | 288 | −0.12 (−0.20; −0.03) | <0.01** | 283 | −0.07 (−0.15; 0.01) | NS | 267 | 0.00 (−0.09; 0.09) | NS |
| Perceived benefits | | | | | | | | | |
| crude model | 315 | 0.04 (−0.08; 0.15) | NS | 302 | 0.01 (−0.11; 0.12) | NS | 291 | 0.00 (−0.10; 0.10) | NS |
| corrected model | 296 | 0.04 (−0.07; 0.16) | NS | 288 | 0.02 (−0.09; 0.13) | NS | 278 | 0.01 (−0.10; 0.11) | NS |
| Processes of change, cognitive | | | | | | | | | |
| crude model | 323 | 0.17 (0.06; 0.28) | <0.01** | 309 | 0.15 (0.04; 0.26) | <0.01** | 296 | 0.05 (−0.06; 0.16) | NS |
| corrected model | 304 | 0.18 (0.06; 0.29) | <0.01** | 294 | 0.17 (0.06; 0.28) | <0.01** | 283 | 0.06 (−0.06; 0.17) | NS |
| Processes of change, behavioral | | | | | | | | | |
| crude model | 325 | 0.20 (0.09; 0.30) | <0.001*** | 312 | 0.25 (0.14; 0.37) | <0.001*** | 298 | 0.12 (0.01; 0.23) | <0.05* |
| corrected model | 304 | 0.18 (0.06; 0.29) | <0.01** | 295 | 0.25 (0.13; 0.36) | <0.001*** | 284 | 0.12 (0.01; 0.23) | <0.05* |

*: *P* < 0.05, **: *P* < 0.01, ***: *P* < 0.001.
Crude model: included variable for group allocation and adjusted baseline value of outcome measure. Corrected model: crude model adjusted for age, gender, baseline physical activity, employment, education, children in household, and smoking. *N*: number of subjects included in analysis; CI: confidence interval; NS: non-significant; positive βs indicate a positive intervention effect for all outcome measures expect for perceived barriers, whereas a negative β indicates a positive intervention effect.

**Table IV.** *Results of subgroup analyses with linear regression analysis regarding the differences in effectiveness of the PACE intervention at 8 weeks (T1), 6 months (T2), and one year (T3)*

| Outcome measure | T1 | | T2 | | T3 | |
|---|---|---|---|---|---|---|
| | β (95%CI) | *P* | β (95%CI) | *P* | β (95%CI) | *P* |
| Self–efficacy, resisting relapse | | | | | | |
| inactive at baseline[a] | 0.42 (0.17; 0.66) | <0.001*** | 0.39 (0.14; 0.65) | <0.01** | 0.35 (0.07; 0.62) | <0.01** |
| active at baseline | 0.23 (−0.03; 0.48) | NS | 0.23 (−0.04; 0.50) | NS | −0.08 (−0.35; 0.20) | NS |
| Barriers | | | | | | |
| smokers[a] | −0.22 (−0.39; −0.05) | <0.01** | −0.15 (−0.32; 0.02) | NS | −0.15 (−0.32; 0.02) | NS |
| non–smokers | −0.07 (−0.16; 0.02) | NS | −0.03 (−0.12; 0.07) | NS | 0.04 (−0.06; 0.13) | NS |
| Perceived benefits | | | | | | |
| inactive at baseline[b] | 0.04 (−0.11; 0.20) | NS | 0.13 (−0.03; 0.28) | NS | 0.01 (−0.13; 0.16) | NS |
| active at baseline | 0.00 (−0.17; 0.16) | NS | −0.10 (−0.26; 0.06) | NS | −0.01 (−0.16; 0.14) | NS |
| Processes of change, cognitive | | | | | | |
| males[c] | 0.27 (0.11; 0.42) | <0.001*** | 0.23 (0.08; 0.38) | <0.01** | 0.08 (−0.07; 0.23) | NS |
| females | 0.07 (−0.09; 0.23) | NS | 0.06 (−0.10; 0.22) | NS | 0.02 (−0.14; 0.18) | NS |

$*P < 0.05$, $**P < 0.01$, $***P < 0.001$.
Subgroup analyses were conducted in the crude model for the outcome measures 'barriers' and 'cognitive processes of change' and in the corrected model for the outcome measures 'perceived benefits' and 'self-efficacy, resisting relapse'. Crude model: included variable for group allocation and adjusted for baseline value of outcome measure. Corrected model: crude model adjusted for age, gender, baseline physical activity, employment, education, children in household, and smoking. CI: confidence interval; NS: non-significant; positive βs indicate a positive intervention effect for all outcome measures expect for perceived barriers, whereas a negative β indicates a positive intervention effect.
[a]Statistically significant differences in effect between the subgroups was observed at T3.
[b]Statistically significant differences in effect between the subgroups was observed at T2.
[c]Statistically significant differences in effect between the subgroups was observed at T1.

statistically significant. The intervention effect on the cognitive processes of change was significantly stronger for the males than for the females at T1. A strong increase in use of cognitive processes was observed for the males, whereas no intervention effect was observed for females.

## Discussion

The PACE intervention applied by Dutch general practitioners was effective in producing a short-term positive effect (i.e. at 8 weeks) on patients' barriers to physical activity, self-efficacy for making time for exercise, self-efficacy for resisting relapse, and on both the cognitive and the behavioral processes of change. At 6-month follow-up this effect was maintained for most outcome measures (except for barriers to physical activity) and at 1-year follow-up the intervention group still showed a significantly higher level of use of the behavioral processes of

change. The results for most outcome measures show that the size of the intervention effect was maintained from the 8-week follow-up until the 6-month follow-up, but dropped to the 1-year follow-up.

The results found in this study are somewhat more positive than previously reported results (Lewis *et al.*, 2002). Most previous studies reported a positive effect of the intervention on the behavioral processes of change, which is comparable to our results. The results on the use of the cognitive processes of change were mixed in previous studies, whereas in the current study significant increase was shown, especially in men. This is contradictory to the results of the GRAD intervention (Sallis *et al.*, 1999; Calfas *et al.*, 2000), in which an increase in the use of cognitive processes of change was observed only in women and not in men. Our results on the decisional balance (pros and cons) are in line with previous studies with a small decrease in barriers and little to no effect on perceived

benefits. However, our results show that PACE was predominantly effective in reducing the smokers' barriers to physical activity, although the difference in effect between the smokers and non-smokers was statistically significant only at 1-year follow-up. One reason for this difference might be that the smokers experienced somewhat higher perceived barriers at baseline [means (SD): 1.27 (0.57) versus 1.14 (0.59), $P < 0.10$] and therefore possibly benefited more from the intervention. As to self-efficacy, the results of our intervention are more positive than those of most previous studies, as the current study showed positive results on both subscales of self-efficacy at the 8-week and the 6-month follow-up. Moreover, this study is one of the first to report on differences in effect between inactive and active subjects. With respect to an increase in self-efficacy for resisting relapse, inactive subjects benefited most from the intervention, although the difference in effect was statistically significant only at 1-year follow-up, at which the inactive subjects still showed a statistically significant increase. Furthermore, positive but non-significant trends on perceived benefits were observed for the inactive subjects, whereas no change was detected for the active subjects.

When comparing our results with the results of previous PACE studies in primary care (Calfas *et al.*, 1997; Norris *et al.*, 2000), the conclusion can be drawn that our intervention resulted in more changes on the determinants of physical activity. Possible explanations for this difference might be that the Dutch GP, in contrast to most American primary care physicians, usually has a longer lasting relationship with his/her patients and that the intervention in our study was somewhat more intensive (four versus two contact moments).

This study has several strengths. First, it is one of few studies examining the effect of an intervention in primary care on determinants of physical activity (Calfas *et al.*, 1996; Norris *et al.*, 2000; Pinto *et al.*, 2001) and the first study to establish this effect at a 1-year follow-up. Second, a large number of subjects were included in the study and high response rates at all follow-up measurements were achieved. Third,

reliable and valid questionnaires were used to assess the effect of the PACE intervention on the determinants of physical activity behavior. Fourth, although we were not able to perform a blind randomization to the intervention or control condition, most subjects in both conditions thought that they were randomized to the control condition. This adds to the reliability of our results. Fifth, it was anticipated that the randomization at the GP level could lead to differences in effect as a result of this procedure. We therefore used multilevel analysis, correcting for this possible correlation.

The present study also has its limitations. A first limitation is the high number of missing values on the social support questionnaire that caused the data to be unfit for analysis. It was thus not possible to test the potential of PACE to enhance social support. The problem with non-response on the social support questions has not been reported before. We can only hypothesize on the reasons for this non-response and it may be that it was caused by the fact that the social support questions were part of the final sections of the questionnaire. A second limitation may be that pros and cons of the decisional balance were measured as separate scales. It is, however, important that the perceived value of these pros and cons are taken into account in relation to each other. We were not able to achieve this with our questionnaires. Third, a relatively small (13.6%), but selective, group of subjects dropped out of the study at 1-year follow-up. Overall, baseline characteristics showed that dropouts were younger, more likely to be inactive and had a higher BMI than 1-year responders. Although dropouts did not differ between the control and intervention group, this selective dropout limits the generalizibility of the results to a slightly older, more active and leaner population of patients.

The results of the present study show that a PACE intervention to promote physical activity in GPs was effective in producing changes in determinants of physical activity at both short (8 weeks)- and medium (6 months)-term follow-up. Future research should focus on the question whether these favorable changes in the determinants of physical activity also lead to changes in the level of physical

activity. Increasing physical activity levels in the population is still one of the key components of preventive measures in public health. Even though the results of this study are positive, actually being able to change physical activity behavior is the essential component on the way to achieving the health benefits associated with regular physical activity. As the PACE intervention was feasible and acceptable in Dutch GP (Van Sluijs *et al.*, 2004), the results of this study indicate that this intervention could be a promising intervention to implement in GP.

## Acknowledgements

## References

Bandura, A. (1986) *Social Foundations of Thought and Actions.* Prentice-Hall, Englewood Cliffs, NJ.

Baranowski, T., Lin, L.S., Wetter, D.W., Resnicow, K. and Hearn, M.D. (1997) Theory as mediating variables: why aren't community interventions working as desired? *Annals of Epidemiology*, **7**, S89–S95.

Boutron-Ruault, M.C., Senesse, P., Meance, S., Belghiti, C. and Faivre, J. (2001) Energy intake, body mass index, physical activity and the colorectal adenomacarcinoma sequence. *Nutrition and Cancer*, **39**, 50–57.

Calfas, K.J., Long, B.J., Sallis, J.F., Wooten, W.J., Pratt, M. and Patrick, K. (1996) A controlled trial of physician counseling to promote the adoption of physical activity. *Preventive Medicine*, **25**, 225–233.

Calfas, K.J., Sallis, J.F., Oldenburg, B. and Ffrench, M. (1997) Mediators of change in physical activity following an intervention in primary care: PACE. *Preventive Medicine*, **26**, 297–304.

Calfas, K.J., Sallis, J.F., Nichols, J.F., Sarkin, J.A., Johnson, M.F., Caparosa, S., Thompson, S., Gehrman, C.A. and Alcaraz, J.E. (2000) Project GRAD: two-year outcomes of a randomized controlled physical activity intervention among young adults. *American Journal of Preventive Medicine*, **18**, 28–37.

CDC (2001) Physical activity trends—United States, 1990–1998. *Morbidity and Mortality Weekly Report*, **50**, 166–169.

Goldstein, H. (1995) *Multilevel Statistical Methods.* Edward Arnold, London.

Lee, I.M., Sesso, H.D. and Paffenberger, R.S. (2000) Physical activity and coronary heart disease risk in men: does the duration of exercise episodes predict risk? *Circulation*, **102**, 981–996.

Lewis, B.A., Marcus, B.H., Pate, R.R. and Dunn, A.L. (2002) Psychosocial mediators of physical activity behavior among adults and children. *American Journal of Preventive Medicine*, **23** (2S), 26–35.

Long, B.J., Calfas, K.J., Wooten, W., Sallis, J.F., Patrick, K., Goldstein, M., Marcus, B.H., Schwenk, T.L., Chenoweth, J., Carter, R., Torres, T., Palinkas, L.A. and Heath, G. (1996) A multisite field test of the acceptability of physical activity counseling in primary care: project PACE. *American Journal of Preventive Medicine*, **12**, 73–81.

Marcus, B.H., Rossi, J.S., Selby, V.C., Niaura, R.S. and Abrams, D.B. (1992) The stages and processes of exercise adoption and maintenance in a worksite sample. *Health Psychology*, **11**, 386–395.

Nichols, J.F., Wellman, E., Caparosa, S., Sallis, J.F., Calfas, K.J. and Rowe, R. (2000) Impact of a worksite behavioral skills intervention. *American Journal of Health Promotion*, **14**, 218–221.

Norris, S.L., Grothaus, L.C., Buchner, D.M. and Pratt, M. (2000) Effectiveness of physician-based assessment and counseling for exercise in a staff model HMO. *Preventive Medicine*, **30**, 513–523.

Oguma, Y., Sesso, H.D., Paffenberger, R.S. and Lee, I.M. (2002) Physical activity and all cause mortality in women: a review of evidence. *British Journal of Sports Medicine*, **36**, 162–172.

Pate, R.R., Pratt, M., Blair, S.N., Haskell, W.L., Macera, C.A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G.W., King, A.L., Krisda, A., Leon, A.S., Marcus, B.H., Morris, J., Paffenbarger, R.S., Patrick, K., Pollock, M.L., Rippe, J.M., Sallis, J. and Wilmore, J.H. (1995) Physical activity and public health, a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, **273**, 402–407.

Pinto, B.M., Lynn, H., Marcus, B.H., DePue, J. and Goldstein, M.G. (2001) Physician-based activity counseling: intervention effects on mediators of motivational readiness for physical activity. *Annals of Behavioral Medicine*, **23**, 2–10.

Prochaska, J.O. and DiClemente, C.C. (1983) Stages and processes of self-change of smoking: toward an intergrative model of change. *Journal of Consulting and Clinical Psychology*, **51**, 390–395.

Sallis, J.F., Grossman, R.M., Pinski, R.B., Patterson, T.L and Nader, P.R. (1987) The development of scales to measure social support for diet and exercise behaviors. *Preventive Medicine*, **16**, 825–836.

Sallis, J.F., Pinski, R.B., Grossman, R.M., Patterson, T.L. and Nader, P.R. (1988) The development of self-efficacy scales for health-related diet and exercise behaviors. *Health Education Research*, **3**, 283–292.

Sallis, J.F., Hovell, M.F., Hofstetter, C.R., Faucher, P., Elder, J.P., Blanchard, J., Caspersen, C.J., Powell, K.E. and Christenson, G.M. (1989) A multivariate study of determinants of vigorous exercise in a community sample. *Preventive Medicine*, **18**, 20–34.

Sallis, J.F., Calfas, K.J., Alcaraz, J.E., Gehrman, C. and Johnson, M.F. (1999) Potential mediators of change in a physical activity promotion course for university students: project GRAD. *Annals of Behavioral Medicine*, **21**, 149–158.

Van Sluijs, E.M.F., Van Poppel, M.N.M., Stalman, W.A.B. and Van Mechelen, W. (2004) Feasibility and acceptability of a physical activity promotion program in general practice. *Family Practice*, **21**, 429–436.

Wannamethee, S.G. and Shaper, A.G. (2001) Physical activity in the prevention of cardiovascular disease: an epidemiological perspective. *Sports Medicine*, **31**, 101–114.

Wendel-Vos, G.C.W., Schuit, A.J., Saris, W.H.M. and Kromhout, D. (2003) Reproducibility and relative validity of the short questionnaire to assess health enhancing physical activity. *Journal of Clinical Epidemiology*, **56**, 1163–1169.