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The long-term effectiveness of need-supportive physical activity counseling compared with a standard referral
in sedentary older adults

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Abstract

This study compared the long-term effectiveness of three physical activity counseling strategies among sedentary older adults: a one-contact referral (REFER), a one-contact individualized walking program (WALK) and a multiple-contact individually-tailored and need-supportive coaching based on the Self-Determination Theory (COACH). Participants ($n = 442$) completed measurements before (pre-test), immediately after (post-test) and one year after (follow-up-test) a ten-week intervention. Linear mixed models demonstrated significant time by condition interaction effects from pre- to post-test. More specifically, WALK and COACH yielded larger increases in daily steps and self-reported physical activity than REFER. Similarly, self-reported physical activity increased more from pre- to follow-up-test in WALK and COACH compared with REFER. Autonomous motivation mediated the effect of perceived need-support on physical activity, irrespective of counseling strategy. These results demonstrate the long-term effectiveness of both a one-contact individualized walking program and a more time-consuming need-supportive coaching, especially in comparison with a standard referral to local opportunities.

Keywords: exercise promotion, referral, walking program, self-determination theory, older adults, longitudinal intervention

The number of older adults in Western societies is increasing rapidly. This results in enormous health care costs given that particularly this population group suffers from impaired functioning and well-being (Crews & Zavotka, 2006; Naughton, Bennett, & Feely, 2006). Despite the important role of physical activity (PA) in healthy ageing, a large proportion of the Western population does not attain the health norm of 30 minutes of moderate intensity PA on five days a week or 20 minutes of strenuous intensity PA three times a week (Kruger, Carlson, & Buchner, 2007; Peel, McClure, & Bartlett, 2005; Philippaerts et al., 2006; Taylor et al., 2004). Consequently, PA promotion among older adults has emerged as a public health priority.

Lifestyle interventions have yielded PA increases among older adults (e.g., Conn, Minor, Burks, Rantz, & Pomeroy, 2003; King, 2001; xxxxx, xxxxx, xxxxx, & xxxxx, 2008). However, PA changes in the long term have been found to be inconsistent (Goldstein et al., 1999; Taylor et al., 2004; Van Der Bij, Laurant, & Wensing, 2002). Moreover, even with limited contact, lifestyle interventions are time- and labor-intensive, which hampers large-scale implementation.

In order to facilitate PA promotion in the wider community, the effectiveness of less time-consuming counseling procedures has been studied (e.g., Dugdill, Graham, & McNair, 2005; Morgan, 2005; Williams, Hendry, France, Lewis, & Wilkinson, 2007). In this respect, referring sedentary adults to supervised PA sessions has been shown to produce a significant increase of the number of participants performing moderate intensity PA (Williams et al., 2007). However, referral from a primary care practitioner to local exercise programs usually succeeds in the short term but is limited in terms of long-term PA engagement (Gusi, Reyes, Gonzales-Guerrero, Herrera, & Garcia, 2008; Williams et al., 2007).

Walking programs of low to moderate intensity constitute another effective and feasible approach to introduce older adults to regular PA (Fisher & Li, 2004; Lamb, Bartlett, Ashley, & Bird, 2002; Lee, Arthur, & Avis, 2007; Parkatti, Perttunen, & Wacker, 2012; xxxxx, in press; Sugden et al., 2008; Taylor et al., 2004). However, given the substantial variety in the way walking interventions are implemented (e.g., pedometer use, supervision intensity and program duration, whether or not group-based or theory-grounded), it is difficult to draw strong and unambiguous conclusions on the effectiveness of walking schemes. Furthermore, according to Ogilvie et al. (2007), no studies on walking programs have shown long-term effects.

As mentioned above, referral and walking interventions are less time-consuming counseling procedures but have failed to demonstrate consistent long-term effects on PA. Most of these procedures lack an underlying theoretical framework, even though previous research underscores the importance of implementing theoretically-grounded behavioral strategies in promoting PA (in older adults) (Hillsdon, Foster, Cavill,

Crombie, & Naidoo, 2005; King, 2001). More specifically, numerous studies suggest that a client-centered counseling approach, in which (older) adults' needs of self-determination are recognized, is especially appropriate to increase their PA (e.g., Biddle & Mutrie, 2008; Dacey, 2005; Ogilvie et al., 2007; Stathi et al., 2003; Taylor et al., 2004). Such need-supportive counseling strategies are based on the Self-Determination Theory (SDT), which is a prominent theoretical framework to facilitate behavioral change (Deci & Ryan, 1985). SDT-based interventions aim at enhancing autonomous types of motivation for any given behavior (e.g., PA). People are autonomously motivated when they engage in an activity because the activity will help them to attain valued goals, because of the personal importance and meaningfulness of the activity, or for reasons of interest, enjoyment or challenge. Autonomously motivated behavior is self-initiated rather than controlled, driven by external demands or to avoid feelings of guilt or shame. Because of its voluntary character, autonomous motivation (AM) is assumed to yield long-term engagement in PA, which is essential for healthy ageing (e.g., Ryan & Deci, 2000; Edmunds, Ntoumanis, & Duda, 2006; Silva et al., 2011). Autonomously motivated behavior can be obtained by supporting the three basic psychological needs postulated by SDT, i.e. autonomy (i.e. experiencing personal control with respect to activity engagement), competence (i.e. experiencing success in attaining desired outcomes) and relatedness (i.e. experiencing meaningful relationships).

Need-supportive programs have been shown to be effective in increasing PA (e.g., Chatzisarantis & Hagger, 2009; Fortier, Sweet, O'Sullivan, & Williams, 2007; xxxxx, 2012). However, the majority of the studies on need-supportive PA interventions have focused on younger and adult populations, whereas SDT has yet to be applied in PA interventions on older adults (Dacey, 2005; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Nevertheless, the framework of SDT seems particularly relevant and applicable to this population group given that ageing may involve feelings of reduced personal control and competence (Dacey, Baltzell, Zaichkowsky, 2008; Jette et al., 1998).

Based on the abovementioned reasoning, we implemented a SDT-grounded PA intervention with a sufficiently long follow-up period among sedentary older adults. Given the importance of considering the cost-effectiveness of a PA counseling strategy, a more time-consuming need-supportive coaching was compared with various one-contact counseling procedures. More specifically, the main purpose of the present study was to compare the short-term effects (i.e. immediately after the intervention) as well as the long-term effects (i.e. one year after the intervention) of three PA counseling strategies among older adults. The first counseling procedure was a standard referral to existing PA programs (i.e. REFER). This procedure consisted of a 15-minute contact with a Health Fitness Specialist who delivered a self-help booklet with local PA opportunities. The second

strategy was the provision of an individualized walking program (i.e. WALK). This counseling method consisted of a 15-minute contact with a Health Fitness Specialist who, in addition to the self-help booklet, explained a structured walking program. Because of the structured format, it was assumed that the walking program inherently supported participants' need for competence, and could therefore be considered as partially need-supportive. The third counseling method was the provision of an individually-tailored program that was assumed to be fully need-supportive (i.e. COACH). This procedure consisted of a multiple-contact PA coaching by a Health Fitness Specialist who explicitly fostered the needs for autonomy, competence and relatedness.

The secondary purpose of this study was to test whether AM would mediate the short- and long-term intervention effects on PA. As mentioned above, SDT assumes AM as a crucial concept to explain sustained behavioral change. Consequently, evidence for the mediating role of AM would provide further support for the validity and utility of this theory with respect to PA promotion among older adults.

Three hypotheses were formulated based on the abovementioned assumptions. In Hypothesis 1, we predicted that, considering their need-supportive character, WALK and COACH would lead to larger short- and long-term PA increases than REFER. In Hypothesis 2, we expected larger PA increases in COACH compared with WALK for two reasons. First, COACH aimed to explicitly facilitate the three basic psychological needs, whereas WALK only focused on fostering the need for competence (inherently) by providing a structured program. Second, interventions with more intense contact have been found to be more effective than those with less intense contact (Conn, Valentine, & Cooper, 2002). In Hypothesis 3, we predicted that, irrespective of intervention, higher levels of perceived need-support would be associated with higher PA levels through AM.

Method

Recruitment and participants

A flow chart of the study is presented in Figure 1. The study took place in three regions across xxxxx, the xxxxx-speaking part of xxxxx. Sedentary adults aged 60 years or older were invited to a locally-organized information session through advertisements in newspapers, internet-based announcements and pamphlets spread via physicians and socio-cultural organizations. In the information session, a Health Fitness Specialist (MSc) (i.e. participants' coach during the PA program) elaborated PA health benefits, PA recommendations and opportunities to integrate PA in their daily routines. Additionally, information on study participation was provided. Older adults willing to participate but already attaining the PA health norm as prescribed by Haskell et al. (2007) were excluded ($n = 229$). More specifically, volunteers performing more than 150 minutes of moderate to strenuous PA during a typical week were not allowed to participate in the study. Furthermore,

volunteers had to obtain a written medical clearance from their physician to participate in PA with fluctuating intensities. If necessary, they were referred to a medical officer to have an additional cardiovascular and respiratory examination ($n = 24$).

Procedure

After obtaining medical permission, a total of 442 participants contacted their coach to make an appointment for pre-test measurements. Three coaches were involved in the study, i.e. one per region. Pre-tests were completed at two points in time, with a one-week interval during which the participants wore a pedometer while they were asked to maintain their normal PA pattern. At the first contact point, the study purpose and procedures were explained and participants gave their written consent. At the second contact point, participants completed self-reports and were randomly assigned to three intervention conditions, i.e. (a) a PA referral condition, (b) an individualized walking condition, and (c) an individually-tailored need-supportive PA coaching condition. During the ten-week program, participants were allowed to keep the pedometer that was used during measurements. Post- and follow-up-tests took place immediately after and one year after the ten-week program, respectively. After post-tests, no contact occurred between coach and client. Participants were not aware of follow-up-tests until three weeks before the measurements took place. The study was approved by the Ethics Committee of the university of xxxxx.

Intervention conditions

REFER. After pre-tests, participants of REFER attended a 15-minute informative session delivered by their coach. Given that the coach only explained and referred to locally-organized PA, his/her role was similar to the role of a sport promoter in xxxxx communities. Participants received a self-help booklet with detailed practical information of local PA opportunities for older adults (e.g., location, costs). REFER can be considered as a minimal intervention condition because neither an individualized PA program nor individually-tailored need-supportive coaching was provided.

WALK. Consistent with REFER, WALK involved a 15-minute one-contact condition in which the coach referred the participants to locally-organized PA. In addition to the self-help booklet, participants of WALK were explained an individualized walking program. This easily accessible program consisted of structured weekly schedules of uninterrupted walks (described as number of steps) on most days of the week. Walking volume and intensity increased gradually and participants were encouraged to progress through the different levels of the walking program according to their individual abilities. Participants' initial level was determined by their score on the six-minute walk test, which was performed during pre-tests. This walk test is

considered to be a valid measure of physical fitness (Enright et al., 2003). Participants could accomplish the program on their own or in a social context (e.g., with significant others, in a social organization). The structured format and gradually increasing difficulty of the program was assumed to facilitate the need for competence. Therefore, WALK was considered to be a partially need-supportive counseling procedure.

COACH. In addition to the abovementioned one-contact procedures, participants of COACH received individually-tailored PA coaching based on SDT. During the ten-week intervention, regular contact between coach and client took place. In an initial 60-minute face-to-face contact, several individual PA goals were set up according to the client's preferences and abilities. Goals, which were specified by PA type, location, time frame, company, possible barriers and solutions, were written down in a personal weekly schedule. Besides endurance activities like walking, the coach provided home-based exercises to improve the participant's strength, flexibility and balance. Every ten days, participants were supported through face-to-face contacts or booster phone calls (maximum 30 minutes), which have both been shown to be effective in behavioral change (xxxxx & xxxxx, 2008). During contact, the coach explicitly fostered the psychological needs postulated by SDT, i.e. autonomy (e.g., by providing PA options), competence (e.g., by providing positive feedback) and relatedness (e.g., by expressing empathy). Moreover, PA goals were evaluated and modified if necessary, barriers were identified and participants were stimulated to persist in PA by using behavior change techniques (Abraham & Michie, 2008) and applying motivational interviewing (Miller & Rollnick, 2002).

Measurements

PA and AM were measured before (pre-test), immediately after (post-test) and one year after (follow-up-test) the intervention. Perceived need-support of the coach was only assessed at post-test.

Pedometer steps. The number of daily steps was measured by Omron pedometers (Walking Style One) which have been applied previously among Western populations (xxxxx, in press; Sugden et al., 2008) and for which accurate reliability and validity have been shown (Holbrook, Barreira, & Kang, 2009). Participants were asked to wear the pedometer during all waking hours, except for water-based activities, for five to seven consecutive days including a weekend. A total of five measurement days is assumed to provide sufficient information on daily steps given the recommended four days to reliably estimate usual PA (Hart, Swartz, Cashin, & Strath, 2011). The weighted mean of daily steps on weekdays and during the weekend (i.e. $(3 \times \text{mean of steps on weekdays} + 2 \times \text{mean of steps on weekend days}) / 5$) was used for further analyses.

Self-reported PA. A self-reported measure of PA was obtained by a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ) for which test-retest reliability and adequate validity have been

demonstrated (Gionet & Godin, 1989; Godin & Shephard, 1985; Kriska & Caspersen, 1997). This brief and easy comprehensible questionnaire has frequently been used in Western populations (e.g., De Bacquer et al., 2010; Edmunds et al., 2006; xxxxx, in press). Participants reported the frequency of mild, moderate and strenuous PA bouts of at least 20 minutes that they performed in a usual seven-day period during the past month. The frequencies were weighted by their metabolic equivalents, i.e. three, five and nine respectively, and summed to obtain an overall measure of self-reported PA.

AM. AM was assessed by four items of the Dutch version of the Behavioural Regulation in Exercise Questionnaire-2 (Markland & Tobin, 2004), which has been shown to be valuable in xxxxx populations (xxxxx, 2011). Items of the subscales of identified regulation (i.e. valuing the benefits of PA; two items) and intrinsic motivation (i.e. experiencing the pleasure of PA; two items) were used to obtain a score for AM (Fortier & Kowal, 2007). Participants responded to each item on a five-point Likert scale, ranging from '1 = not at all true for me' to '5 = very true for me'. Cronbach's α for pre-, post- and follow-up-test were .68, .74 and .82, respectively, indicating sufficient to good internal consistency.

Perceived need-support of the coach. A modified version of the Teacher As Social Context Questionnaire (Belmont, Skinner, Wellborn, & Connell, 1988) was used to measure perceived need-support of the coach. This questionnaire has been applied in previous research among Western populations (e.g., Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Vansteenkiste, Sierens, Soenens, Luyckx, & Lens, 2009) and assesses the three dimensions of coaches' behavior postulated by SDT, i.e. autonomy (eight items; e.g., 'My coach listens to my opinion and ideas'), competence (eight items; e.g., 'My coach shows me how to solve problems for myself') and relatedness (eight items; e.g., 'My coach really cares about me'). Participants indicated their agreement with the items on a five-point Likert scale, ranging from '1 = completely disagree' to '5 = completely agree'. As suggested by Vansteenkiste, Sierens, Soenens, Luyckx, and Lens (2009), a general measure of perceived need-support, based on the 24 items, was used for further analyses. Very good internal consistency was shown with a Cronbach's α of .84.

Statistical analyses

SPSS 16.0 was used for data analysis (SPSS Inc, Chicago, IL, USA). Differences between conditions were assessed with one-way ANOVA and chi-square tests (χ^2). Linear mixed models with an unstructured covariance structure were executed to analyze between-condition differences in change over time. Differences in changes over time between separate conditions were determined by contrast estimates. Mixed model analysis is a likelihood-based approach modeling all observations with no attempt at imputation or adjustment for

missing values. Lane (2008) indicated this method as reliable and statistically grounded for handling missing values in a longitudinal design. Indirect effects of perceived need-support on PA through AM were tested by the bootstrapping procedure (Preacher & Hayes, 2008). Bias-corrected confidence intervals (95% CI) of the indirect effects were generated with 2000 resamples. Mediation analyses were conducted with pre-test values of PA included as covariate. When participants' PA level exceeded three standard deviations or more from the PA mean score at pre-, post- or follow-up-test, they were considered as an outlier and therefore excluded from analyses (steps: $n = 14$; self-reported PA: $n = 32$). No significant differences occurred with respect to the number of outliers between REFER, WALK and COACH (steps: $\chi^2 = 0.122$, $p = .941$; self-reported PA: $\chi^2 = 0.739$, $p = .691$). Furthermore, changes in PA were not significantly different between the three regions (3 (time) by 3 (conditions) by 3 (regions) ANOVA: steps: $F = .835$, $p = .572$; self-reported PA: $F = .605$, $p = .767$). Consequently, region was not included as between-factor for data analysis. Significance level was set at $p < .05$.

Results

Demographic profile

The mean age was 69.48 ± 6.71 years, with a minority of the participants (22.2%) aged 75 years or older. One third of the sample consisted of men. Most participants (64.3%) were married or lived together with their partner. The average number of educational years was 12.08 ± 2.76 , with 32.6% of the participants having obtained a college or university degree. The mean body mass index was 27.09 ± 3.93 kg/m², indicating that the sample was on average overweight. A self-reported score on health status of 3.63 ± 0.65 on a five-point Likert scale showed that participants initially estimated their health as moderate to good. No significant baseline differences occurred between REFER, WALK and COACH with respect to abovementioned variables, except for marital status. More specifically, a larger proportion of the participants of COACH was married compared with REFER ($\chi^2 = 10.399$, $p = .006$).

Dropout

The number of dropouts (i.e. participants who neither completed questionnaires nor wore the pedometer) and the reasons are presented in Figure 1. Dropouts were 4.5% and 21.3% at post- and follow-up-test, respectively, with no significant differences between REFER, WALK and COACH (post-test: $\chi^2 = 5.265$, $p = .072$; follow-up-test: $\chi^2 = 2.425$, $p = .297$). The main reasons for dropping out were a lack of interest and health problems (e.g., respiratory problems, infection). No significant differences emerged between dropouts and non-dropouts with respect to the abovementioned demographic variables, except for age. More specifically, dropouts at follow-up were significantly older than non-dropouts ($F = 6.994$, $p = .008$). Moreover, a

significantly lower number of daily steps at baseline was found in dropouts compared with non-dropouts (post-test: $F = 4.854$, $p = .028$; follow-up-test: $F = 4.271$, $p = .039$).

Intervention effects on PA

PA at pre-test did not significantly differ between the conditions (steps: $F = 0.176$, $p = .838$, $d = 0.02$; self-reported PA: $F = 2.283$, $p = .103$, $d = 0.06$). While no significant 3 (time) by 3 (conditions) interaction effect was found for pedometer steps ($p = .129$), mixed model analyses indicated a significant difference in change over time between the conditions for self-reported PA ($p = .009$) (table 1; figure 2). Furthermore, a main time effect was found for pedometer steps ($p < .001$) and self-reported PA ($p < .001$), indicating an overall PA change across the conditions. More specifically, overall significant increases were found in all three interventions for pedometer steps (REFER: $F = 6.110$, $p = .003$, $d = 0.74$; WALK: $F = 16.878$, $p < .001$, $d = 1.41$; COACH: $F = 14.572$, $p < .001$, $d = 1.02$) and self-reported PA (REFER: $F = 41.191$, $d = 1.69$; WALK: $F = 89.696$, $d = 2.47$; COACH: $F = 147.552$, $d = 3.18$; all $p < .001$).

Contrast estimates (table 2) showed significant (borderline) differences in pre- to post-test changes of PA between REFER on the one hand and WALK (steps: $t = 2.463$, $p = .014$; self-reported PA: $t = 2.674$, $p = .008$) and COACH on the other hand (steps: $t = 1.933$, $p = .054$; self-reported PA: $t = 2.254$, $p = .025$). Nevertheless, all three conditions significantly increased in pedometer steps and self-reported PA from pre- to post-test (steps: REFER: 95% CI = - 1017.649 to - 236.724, $p = .002$, $d = 0.24$; WALK: 95% CI = - 1853.616 to - 911.667, $p < .001$, $d = 0.52$; COACH: 95% CI = - 1673.129 to - 770.816, $p < .001$, $d = 0.45$; self-reported PA: REFER: 95% CI = - 12.026 to - 7.065, $d = 0.74$; WALK: 95% CI = - 17.672 to -11.754, $d = 1.13$; COACH: 95% CI = - 16.521 to - 11.369, $d = 1.05$; all $p < .001$). At post-test, one-way ANOVAs indicated significant (borderline) differences between the conditions with respect to pedometer-based and self-reported PA. More specifically, WALK and COACH showed significantly higher PA levels than REFER (steps: $F = 3.089$, $p = .047$, $d = 0.31$; WALK>REFER, $p = .020$; COACH>REFER, $p = .061$; self-reported PA: $F = 2.937$, $p = .054$, $d = 0.29$; WALK>REFER, $p = .019$).

Similarly to pre- to post-test results, all three conditions significantly increased in self-reported PA from pre- to follow-up-test (REFER: 95% CI = - 17.173 to - 9.800, $d = 0.92$; WALK: 95% CI = - 21.728 to - 15.424, $d = 1.24$; COACH: 95% CI = - 22.434 to - 17.520, $d = 1.37$; all $p < .001$), with larger increases in WALK and COACH compared with REFER (respectively, $t = 2.205$, $p = .028$ and $t = 2.893$, $p = .004$) (table 2). With respect to pedometer steps, the significant time by condition interaction effects disappeared from pre- to follow-up-test. However, significant pre- to follow-up-test increases in pedometer steps were found in WALK

and COACH (WALK: 95% CI = - 1005.437 to - 94.189, $p = .018$, $d = 0.21$; COACH: 95% CI = - 861.556 to - 65.203, $p = .023$, $d = 0.18$), while no changes occurred in REFER (95% CI = - 439.530 to 374.741, $p = .875$, $d = 0.02$). No significant differences in PA were found between the three conditions at follow-up-test (steps: $F = 1.636$, $p = .197$, $d = 0.26$; self-reported PA: $F = 2.138$, $p = .120$, $d = 0.27$).

Participants who increased their PA level had significantly lower pre-test scores than those who did not increase in PA (pre- to post-test: steps: $F = 57.527$, $d = 0.85$; self-reported PA: $F = 118.340$, $d = 1.56$; pre- to follow-up-test: steps: $F = 76.099$, $d = 1.03$; self-reported PA: $F = 63.205$, $d = 1.38$; all $p < .001$). This finding points out that especially individuals with initially lower PA levels benefited from the intervention.

Mediation analyses

Perceived need-support. Perceived need-support of the coach after the intervention was 4.500 ± 0.416 , 4.553 ± 0.408 and 4.635 ± 0.306 in REFER, WALK and COACH, respectively. Despite the relatively high score in each condition, significant differences were found between the conditions ($F = 4.430$, $p = .012$, $d = 0.14$). More specifically, perceived need-support was significantly higher in COACH than in REFER ($p = .003$).

AM. Pre-, post- and follow-up-test scores of AM were 3.867 ± 0.791 , 4.011 ± 0.757 and 3.994 ± 0.738 , respectively. AM did not significantly differ between the three conditions (pre-test: $F = 0.318$, $p = .728$, $d = 0.02$; post-test: $F = 0.272$, $p = .762$, $d = 0.09$; follow-up-test: $F = 0.025$, $p = .975$, $d = 0.01$). Moreover, changes in AM were not significantly different between REFER, WALK and COACH (3 (time) by 3 (conditions) interaction: $F = 0.608$, $p = .657$, $d = 0.13$; pre- to post-test: $F = 0.275$, $p = .760$, $d = 0.08$; pre- to follow-up-test: $F = 0.933$, $p = .395$, $d = 0.16$). However, AM significantly increased from pre- to post- and to follow-up-test (pre- to post-test: $F = 9.448$, $p = .002$, $d = 0.19$; pre- to follow-up-test: $F = 6.144$, $p = .014$, $d = 0.17$).

Mediation through AM. Bootstrapping analyses (table 3) demonstrated significant effects of perceived need-support on AM at post- and follow-up-test (α -path). This means that, irrespective of intervention, the higher the perceived need-support after the intervention, the more participants were autonomously motivated to engage in PA, even one year after the intervention. Moreover, significant β -paths indicated that higher levels of AM were associated with higher PA levels, which is consistent with SDT-based assumptions. Confidence intervals demonstrated a significant contribution of AM to the indirect effect of perceived need-support on PA ($\alpha\beta$ -path). At post-test, the mediator models with AM as a proposed mediator explained 29.60% ($R^2 = 0.2960$, $F = 49.842$, $p < .001$) of the variance in pedometer-based PA and 8.49% ($R^2 = 0.0849$, $F = 11.849$, $p < .001$) of the variance in self-reported PA. At follow-up-test, respectively 33.70% ($R^2 =$

0.3370, $F = 48.387$, $p < .001$) and 11.35% ($R^2 = 0.1135$, $F = 12.980$, $p < .001$) of the variance in PA could be explained by the mediator models.

Discussion

This study was designed to compare the (long-term) effects of three PA promotion strategies among older adults: (a) one-contact referral to existing local PA opportunities (i.e. REFER), (b) one-contact provision of an individualized walking program (i.e. WALK), and (c) multiple-contact individually-tailored PA coaching based on SDT (i.e. COACH). As hypothesized and consistent with previous research, post-intervention PA increases were found in REFER, WALK and COACH (e.g., Chatzisarantis & Hagger, 2009; Gusi et al., 2008; De Greef, Deforche, Tudor-Locke, & De Bourdeaudhuij, 2010; Ogilvie et al., 2007). These findings suggest that various promotion strategies can be successful in enhancing PA in sedentary older individuals who are motivated to increase their PA level. Furthermore, previous research is extended by demonstrating effects one year after the intervention. This is noteworthy given that, according to Van Der Bij, Laurent, and Wensing (2002), the few intervention studies on older adults that did examine PA effects in the long term revealed inconsistent results.

Although a standard referral produced significant improvements, WALK and COACH, which were (partially) need-supportive counseling procedures, yielded larger PA increases. This finding, although more pronounced from pre- to post-test than from pre- to follow-up-test, is consistent with hypothesis 1 and suggests that providing sedentary older adults an individualized program and approaching them in a need-supportive way is more effective than referring them to local PA. In accordance, Orrow et al. (2012) found no evidence to recommend referral schemes over counseling interventions. The larger improvements in WALK compared with REFER are consistent with Lamb, Bartlett, Ashley, and Bird (2002), who stated that health walks are more effective in increasing moderate intensity PA than providing information. In addition, several reasons could explain the larger PA increases in COACH compared with REFER. First, COACH demonstrated higher levels of perceived need-support than REFER, which is assumed to facilitate (long-term) behavioral change (Deci & Ryan, 2000). Second, a larger proportion of the participants in COACH was married compared with REFER. Accordingly, COACH reported higher levels of perceived social support from family than REFER, which might have enhanced the effectiveness of COACH. Third, COACH involved a multiple-contact procedure whereas REFER was limited to a single 15-minute contact between coach and client. This difference in attention may have produced higher PA levels in COACH compared with REFER. Furthermore, given that a structured and individualized PA plan was designed in WALK and COACH, the PA increases are consistent with the goal-

setting theory of Locke and Latham (1990), which underscores the importance of concrete and realistic goal-setting in behavior change.

Contrary to hypothesis 2, no significant differences in PA emerged between WALK and COACH. The similar PA pattern in these two conditions suggests that facilitating the need for competence by providing a structured program and explicitly fostering needs during coaching can be equally effective in increasing PA among older adults. This is consistent with previous research on PA promotion, in which it was suggested that supporting only one psychological need postulated by SDT can be sufficient to produce effects in older adults (Dunn, Andersen, & Jakicic, 1998; Stewart et al., 2001). More specifically, feelings of competence might have been facilitated by the structure of the walking program; By providing concrete and realistic weekly walking schemes with progressively increasing volume and intensity, participants were likely to experience success. Feelings of control might have been facilitated by providing participation as well as program autonomy. Finally, interpersonal relatedness might have been facilitated by completing the walks with meaningful others, assuming that walking is considered as easily accessible and therefore would constitute the preferred type of PA among older adults (Ogilvie et al., 2007). With respect to the individually-tailored need-supportive program, the coach explicitly fostered the need for autonomy, the need for competence and the need for relatedness.

The need-supportive character of the interventions in both WALK and COACH appears to be confirmed by the absence of significant differences in perceived need-support between these two interventions. However, the provided need-support in WALK is implicit to the program and thus rather hypothetical. Moreover, there may also be other explanations for the PA increases in WALK (e.g. walking as the preferred PA type among older adults). Furthermore, it should be noted however that perceived need-support was rated high (i.e. over 4.50 on a five-point Likert scale) in all three conditions, and thus also in REFER. This is possibly inherent to the participants' sample, i.e. older adults, who are a grateful population and probably pleased to contribute to a scientific PA program. Within this population, every positive contact (e.g., the 15-minute informative session) can be experienced as need-supportive.

Besides the probably need-supportive perception of the 15-minute contact, several reasons can explain the improvements in REFER. First, given that participants were already motivated to increase their PA, an informative session might have been sufficient to lead them into PA behavior. Second, all participants received a pedometer after pre-tests, which could have resulted in measurement and motivational effects on the increase of PA (Kang, Marshall, Barreira, & Lee, 2009). Third, the pre- to post-test increases in PA may to some extent reflect a Hawthorne effect, meaning that individuals might have changed their PA behavior because of their

participation to the study and to please the coaches. However, the increases in PA were substantial and lasted in the long term, suggesting a sustained intervention effect in REFER as well.

Although the pedometer-based and self-reported measures of PA showed similar patterns from pre- to post- and to follow-up-test (i.e. significant increases), a discrepancy emerged from post- to follow-up-test. While the total number of steps declined after the intervention, self-reported PA further increased, with no differences between the intervention conditions. Several reasons may account for these different post-intervention PA patterns: (a) Different instruments measure different types of PA: While pedometers mainly measure activities that include steps, the GLTEQ also asks for a wide range of activities that does not generate steps, e.g. upper body movements or swimming; (b) The reference period: While the number of daily steps specifically referred to the previous five to seven days, self-reported PA addressed a typical week during the past month; (c) Different measurement tools approach various PA intensities in a different way: While pedometers do not take into account various PA intensities, the overall PA score specified by the GLTEQ is obtained by weighting the frequencies of mild, moderate and strenuous PA by three, five and nine, respectively. Given that especially moderate and strenuous PA increased from post- to follow-up-test, post-intervention increases in self-reported PA should have been less pronounced when intensity was not or less taken into account; (d) An overshooting effect or hyper reaction of PA at post-test: Given that participants knew that they would be measured again after the intervention, they may have produced more efforts to live up to the perceived expectations. The hyper reaction of PA can also be attributed to seasonal effects given that post-tests occurred during summer.

The abovementioned discrepancy between pedometer steps and self-reported PA post-intervention emphasizes the multidimensional and complex character of PA behavior. According to Warren et al. (2010), assessing PA is difficult and no single method can capture all PA subcomponents and domains of interest. Absolute values of PA should thus be interpreted with caution. However, despite the measurement issues involved in pedometer-based and self-reported assessment tools, both methods have been found to be valid and reliable for measuring PA (e.g., Gionet & Godin, 1989; Holbrook et al., 2009; Kriska & Caspersen, 1997; Sugden et al., 2008; Warren et al., 2010). Furthermore, the observed trends from pre- to post- and to follow-up-test on pedometer steps were generally supported by self-reports, although somewhat more pronounced.

As postulated by SDT (Deci & Ryan, 1985), social environments that support individuals' basic psychological needs facilitate autonomously motivated behavior. The voluntary character of this type of self-determined motivation is crucial for continued engagement in health behavior (Fortier, Duda, Guerin, &

Teixeira, 2012). As proposed in hypothesis 3 and consistent with previous research (e.g., Fortier et al., 2007; xxxxx, 2012), AM mediated the effect of perceived need-support of the coach on PA. These findings imply that, irrespective of condition, higher levels of perceived need-support yielded higher PA through AM, even one year after the intervention. To enlarge the effectiveness, PA promotion should thus focus on facilitating AM. More specifically, individuals should be encouraged to engage in and maintain PA behavior (a) for obtaining personally important PA outcomes (i.e. identified regulation), or (b) for its own sake (i.e. intrinsic motivation).

In order to demonstrate the relevance of the findings in terms of health promotion, the results were translated into PA levels needed to obtain health benefits. Tudor-Locke et al. (2011), who reported step-based recommendations that correspond with the current public health PA guidelines, indicated that older adults should accumulate approximately 7000 steps each day to gain health benefits. In the current study, 29.2%, 48.1% and 35.7% of the participants obtained this threshold at pre-, post- and follow-up-test, respectively. These findings point out the potential of various PA interventions to increase the proportion of older adults being physically active enough, even one year after the intervention.

Notwithstanding the positive influences of all three counseling strategies on PA behavior in older adults, WALK and COACH were found to be more effective than REFER. However, even though both WALK and COACH were more successful than REFER in increasing PA in the long term, it should be noted that the counseling procedure of WALK was less time-consuming than COACH. More specifically, WALK involved a 15-minute informative session compared with the regular contacts between coach and client in COACH. This cost-effectiveness makes the walking intervention particularly beneficial to implement in a wider community. The large-scale implementation potential of WALK as a one-contact strategy is worth mentioning given that most effective interventions involve regular face-to-face contact (Dunn et al., 1998).

Before concluding, specific strengths and limitations of this study should be pointed out. First, this study on need-supportive coaching involved a longitudinal intervention with a year-round follow-up period. This design allowed us to identify long-term causal relationships between the intervention, perceived need-support, AM and PA, rather than merely cross-sectional associations. Second, given the SDT-assumption that need-supportive coaching yields sustained behavior through AM, mediation effects were studied. This enabled us to understand why an intervention is effective prior to the implementation in the wider community. Third, given that both pedometer steps and self-reported PA involve measurement issues, the use of both types of PA outcomes provides a more complete and accurate PA assessment.

A first limitation constitutes the lack of a strict control condition. This prevents us from drawing strong conclusions on the impact of the interventions relative to measurement and attention effects. More specifically, participants could have increased their PA level because of their participation in the study (e.g., testing effects) or because of the (multiple) contact point(s) with the coach (e.g., attention effects) rather than because of the characteristics of the counseling procedures. Consequently, the (magnitude of the) intervention effects might have been overestimated. However, the demonstrated effectiveness in the long term suggests substantial intervention effects. Moreover, given that aging is associated with a decreased PA engagement, the pre- to follow-up-test increases in PA suggest that all three intervention conditions have the potential to counteract the age-related decline in PA. Because participants were sedentary older adults motivated to increase their PA level, we considered it more ethical to include a minimal intervention rather than no-treatment condition. Second, recruitment occurred through media campaigns which involve voluntarily participation in the study. Consequently, the sample consisted of sedentary but relatively healthy and highly educated older adults who were initially already motivated to increase their PA. This self-selection recruitment procedure reduces the generalizability of the findings to older adults who are less motivated, have less education, and are in poorer health.

In conclusion, this study provides evidence for the effectiveness of three PA programs varying in counseling method and intensity among sedentary older adults. Given their one-contact character, procedures such as referral or the provision of a structured walking program appear to be potentially effective health-promoting strategies to implement at a large scale. However, an individualized and (partially) need-supportive PA program seems to be more successful in long-term PA engagement than referral to widespread PA opportunities. The findings underscore the importance of facilitating AM in the transition from an inactive to regularly active lifestyle in older adults. The intervention study constitutes a promising step in the promotion of PA among older adults in the wider community, especially in those with initially low PA levels.

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Figure 1. Flow chart of the study

Figure 1. Response and participation rate throughout the recruitment procedure and intervention study. REFER, referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition.

Figure 2. Intervention effects on PA

Figure 2. PA, physical activity; GLTE-score, physical activity score by the Godin Leisure-Time Exercise Questionnaire; PRE, physical activity score at pre-test; POST, physical activity score at post-test; 1-YR FU, physical activity score one year after the intervention; REFER, referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition.

PHYSICAL ACTIVITY COUNSELING IN OLDER ADULTS

Table 1

Estimated means (SE) at pre-test, pre- to post-test and pre- to follow-up-test change scores for pedometer-based and self-reported PA in REFER, WALK and COACH, 3 (time) x 3 (conditions) interaction effects and (3) time effects for PA

	REFER	WALK	COACH	3 x 3 interaction		Time	
	Mean	Mean	Mean	<i>F</i>	Cohen's <i>d</i>	<i>F</i>	Cohen's <i>d</i>
	(SE)	(SE)	(SE)				
<u>Pedometer-based PA</u>							
(steps/day)							
Pre	5877.542 (210.378)	5923.207 (213.364)	5734.334 (209.459)				
Δprepo	+ 618.849 (232.936)	+ 1384.384 (234.260)	+ 1224.784 (238.590)	1.797	0.27	36.215 ***	1.05
Δprefu	+ 39.766 (213.814)	+ 538.862 (215.439)	+ 460.606 (213.258)				
<u>Self-reported PA</u>							
(GLTE)							
Pre	14.883 (0.956)	14.195 (0.960)	12.099 (0.956)				
Δprepo	+ 9.614 (1.259)	+ 14.710 (1.247)	+ 13.968 (1.287)	3.406 **	0.18	239.278 ***	0.68
Δprefu	+ 13.617 (1.508)	+ 18.605 (1.549)	+ 20.020 (1.478)				

Note. SE, standard error; PA, physical activity; REFER, PA referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition; Pre, pre-test value; Δprepo, change score from pre- to post-test; Δprefu, change score from pre- to follow-up-test; 3 x 3 interaction, interaction effect over (3) time and between (3) conditions; Time, overall time effect over the conditions; GLTE, score on Godin Leisure-Time Exercise Questionnaire.

, $p < .01$; *, $p < .001$

PHYSICAL ACTIVITY COUNSELING IN OLDER ADULTS

Table 2

Condition difference changes from pre- to post-test and from pre- to follow-up-test for pedometer-based and self-reported PA

	Δ prepo			Δ prefu		
	Contrast estimate (SE)	Cohen's <i>d</i>	95% CI	Contrast estimate (SE)	Cohen's <i>d</i>	95% CI
<u>Pedometer-based PA</u>						
(steps/day)						
WALK vs. REFER	765.535 (310.766) *	0.25	154.474 to 1376.597	499.096 (300.952)	0.18	- 92.889 to 1091.081
COACH vs. REFER	605.935 (313.429) £	0.12	- 10.347 to 1222.217	420.411 (298.305)	0.15	- 166.387 to 1007.209
COACH vs. WALK	-159.600 (315.430)	0.05	- 779.809 to 460.608	- 78.685 (300.805)	0.03	- 670.387 to 513.017
<u>Self-reported PA</u>						
(GLTE)						
WALK vs. REFER	5.093 (1.905) **	0.27	1.348 to 8.838	4.989 (2.262) *	0.24	0.539 to 9.439
COACH vs. REFER	4.352 (1.931) *	0.23	0.557 to 8.147	6.404 (2.214) **	0.32	2.049 to 10.759
COACH vs. WALK	- 0.741 (1.923)	0.04	- 4.522 to 3.040	1.415 (2.242)	0.07	- 2.995 to 5.826

Note. SE, standard error; PA, physical activity; REFER, PA referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition; Δ prepo, change score from pre- to post-test; Δ prefu, change score from pre- to follow-up-test; 95% CI, 95% confidence interval; GLTE, score on Godin Leisure-Time Exercise Questionnaire.

*, $p < .05$; **, $p < .01$; £, $p = .054$

PHYSICAL ACTIVITY COUNSELING IN OLDER ADULTS

Table 3

Mediation effects of AM on pedometer-based and self-reported PA at post- and follow-up-test

	α -path	β -path	$\alpha\beta$ -path			
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	95% CI of $\alpha\beta$		
<u>At post-test</u>						
Pedometer-based PA (steps/day)						
AM	0.214 (0.105)*	376.669 (161.327)*	80.726 (57.792)	4.897	to	245.435
Self-reported PA (GLTE)						
AM	0.371 (0.098)***	2.145 (0.968)*	0.796 (0.447)	0.146	to	1.938
<u>At follow-up-test</u>						
Pedometer-based PA (steps/day)						
AM	0.344 (0.112)**	664.484 (155.639)***	228.367 (100.324)	77.653	to	493.557
Self-reported PA (GLTE)						
AM	0.317 (0.112)**	4.818 (1.187)***	1.529 (0.671)	0.442	to	3.193

Note. Pre-test PA was included as covariate; AM, autonomous motivation; PA, physical activity; α , estimate of perceived need-support at post-test on the proposed mediator, i.e. AM; β , estimate of the direct effect of the proposed mediator on PA while controlling for the effect of perceived need-support; $\alpha\beta$, estimate of the indirect effect of perceived need-support on PA through the proposed mediator; SE, standard error; 95% CI, 95% bias corrected confidence interval with the empirically derived bootstrapped sampling distribution of $\alpha\beta$ (result of 2000 bootstrap resamples); GLTE, score on Godin Leisure-Time Exercise Questionnaire.

*, $p < .05$; **, $p < .01$, ***, $p < .001$