Year-round effectiveness of physical activity
counseling on subjective well-being: A self-
determination approach among Flemish
sedentary adults

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Abstract

This study evaluated the year-round effectiveness of need-supportive physical activity counseling on various dimensions of subjective well-being. Flemish adults who did not attain the recommended level of physical activity were assigned to an intervention ($n = 92$) or a control condition ($n = 34$). Participants of the intervention condition received a four-month physical activity coaching based on the Self-Determination Theory. The coaching was limited to five individual contact moments with a bachelor in kinesiology specializing in health-related physical activity counseling. Self-reports on various intensities of physical activity and physical and psychological well-being were completed before (i.e. pre-test), immediately after (i.e. post-test) and one year after (i.e. follow-up-test) the intervention. Repeated measurements ANOVAs showed significant time by condition interaction effects with respect to physical well-being. More specifically, physical well-being increased significantly in the intervention condition from pre- to post-test and from pre- to follow-up-test, whereas no changes occurred in the control condition. Bootstrapping mediation analyses revealed that the changes in physical well-being were mediated by changes in strenuous intensity physical activity. The findings demonstrate the year-round effectiveness of need-supportive physical activity counseling with a limited number of contact moments on (physical) well-being and suggest its potential as a public health initiative.

Keywords: longitudinal intervention; well-being; physical activity; Self-Determination Theory.

Introduction

According to the World Health Organization (2009), individuals should experience a sufficiently high level of well-being in order to realize their full potential, work productively and contribute to the community. Consequently, worldwide efforts have been made to improve and ensure the population's well-being. Well-being reflects an individual's life satisfaction and can be defined as the cognitive and affective evaluation of one's life (Diener et al. 2002). The concept of well-being is closely related to the concept of quality of life, which refers to the degree to which individuals judge the overall quality of their life in a favorable way (Fox 1999; Grace and Ji-Hyun 2008; Rejeski and Mihalko 2001). More specifically, it involves individuals' perception of their current position in life in relation to their goals and expectations (Pristed et al. 2012; Sirgy 2001). Well-being and quality of life are broad ranging concepts and should be considered as multidimensional, including both individuals' physical health and their psychological state (e.g. Lampinen et al. 2006; McAuley and Rudolph 1995; Pristed et al. 2012; Stathi et al. 2002; World Health Organization 1997).

Different dimensions of well-being and quality of life have been shown to be substantially improved by regular physical activity (PA) (e.g. Biddle and Mutrie 2008; Fox 1999; Ku et al. 2007; Mesquita et al. 2011; Penedo and Dahn 2005; Rejeski and Mihalko 2001). Moreover, higher intensity levels of PA yield larger improvements in both aerobic fitness and psychological well-being compared with lower intensity PA (e.g. Norris et al. 1992; Swain and Franklin 2006). Notwithstanding the well-established positive influences of PA on well-being, the majority of the Western population does not attain the recommended levels of 30 minutes of moderate intensity PA on five days a week or 20 minutes of vigorous intensity PA three times a week (Varo et al. 2003). In order to affect well-being and quality of life at community level, (higher intensity) PA promotion should thus be considered as one of the major public health challenges.

Numerous studies have already demonstrated increased PA by implementing lifestyle interventions in which PA is integrated into one's daily life (e.g. Dunn et al. 1998; Foster et al. 2005; Opdenacker et al. 2008b). Among the overall reported positive results, theory-based health promoting strategies have been found to be most effective (Glanz and Bishop 2010; McAuley and Rudolph

1995). In this respect, the Self-Determination Theory (SDT) can be considered as a promising theoretical foundation for (long-term) health behavior changes such as PA (Ryan and Deci 2000).

SDT-based interventions aim at enhancing self-determined, i.e. self-initiated and volitional, forms of motivation because these motivational regulations are associated with a more positive attitude towards PA and with sustained PA engagement (e.g. Fortier et al. 2011; Van Hoecke et al. 2012). According to SDT, self-determined PA can be facilitated by supporting the three basic psychological needs, i.e. the need for autonomy, the need for competence and the need for relatedness (Deci and Ryan 1985). The need for autonomy refers to the experience of one's choice in and ownership of a given behavior; The need for competence implies the pursuit of experiencing mastery and success; The need for relatedness involves the experience of supportive relationships and the reciprocal concern for meaningful others.

Motivational interviewing (Markland and Vansteenkiste 2007; Miller and Rollnick 2002) has been identified as an appropriate collaborative counseling technique to facilitate the satisfaction of these three needs and hence to pursue self-determined PA. More specifically, applying the principles of motivational interviewing is assumed to strengthen individuals' self-determined motivation to attain a specific goal by helping them to explore and resolve their ambivalence within an atmosphere of acceptance (Miller and Rollnick 2002).

Previous research has provided evidence that PA programs that support the needs for autonomy, competence and relatedness yield self-determined forms of motivation, and accordingly result in long-term engagement in, particularly higher intensity, PA (e.g. Teixeira et al. 2012; Van Hoecke et al. 2012). For example, a five-week school-based intervention demonstrated stronger intentions and higher participation rates in leisure-time PA among pupils who were taught by autonomy supportive teachers compared with pupils who were taught by non-autonomy supportive teachers (Chatzisarantis and Hagger 2009). Similarly, Wilson and colleagues (2005) showed that adolescents who were involved in a four-week intervention based on SDT significantly increased in moderate and vigorous intensity PA whereas no changes were found in a comparison group receiving general health education. Within the health care context, Fortier et al. (2007) concluded that patients receiving brief and intensive autonomy supportive

counseling showed higher levels of perceived autonomy support and self-determined motivation at six weeks and higher PA levels at 13 weeks compared with patients receiving only brief counseling from their health-care provider.

In addition to studying the effectiveness of (need-supportive) PA programs, understanding the motivational processes leading to sustained PA behavior is beneficial in the development of effective PA promoting strategies. Accordingly, several SDT-grounded studies have tested the mediating influences of motivational regulations and perceived need-support on behavioral changes (Fortier et al. 2012; Teixeira et al. 2012). In this respect, self-determined motivation and perceived competence have been shown to significantly predict PA among patients receiving autonomy supportive counseling (Fortier et al. 2007). Similarly, Silva et al. (2010a) demonstrated a positive influence of self-determined motivation on moderate and strenuous PA at 12 and 24 months among overweight women who were involved in a year-round need-supportive program.

Besides the demonstrated enhancement of self-determined (PA) behavior, the satisfaction of the three needs is assumed to be essential to experience an ongoing sense of integrity and well-being across individuals' lifespan (Ryan and Deci 2000; Vansteenkiste et al. 2010). More specifically, individuals who perceive support for autonomy, competence and relatedness are expected to have higher levels of vitality, self-esteem, energy, mental health, functioning, and positive affection (Deci and Vansteenkiste 2004).

The positive influence of perceived need-support on well-being is presumed to be universal, and thus valid across time, populations and cultures. However, the degree to which perceived need-support improves health and well-being varies between individuals in that it depends on the attainment of one's personal goals. More specifically, need-satisfaction will only enhance well-being within a context that is central to the individual's life such as work or leisure-time (Ryan and Deci 2000). In addition to the variation of well-being between individuals (i.e. according to the attainment of one's goals), the level of well-being can fluctuate within an individual (i.e. according to the degree to which one feels more autonomous, competent and related to others during his/her daily activities). In this respect, individuals' psychological functioning, well-being and emotions such as mood, vitality and self-esteem can fluctuate every day as a result of the variations in their experienced need-support (Gagné 2003; Reis et al. 2000).

As mentioned above, increased PA levels on the one hand and perceived need-support on the other hand have been related to improved subjective health and well-being. Nevertheless, need-supportive interventions that aim to promote PA within a population have mainly focused on the effects on PA but have rarely examined the effects on well-being (e.g. Lloyd and Little 2010; Teixeira et al. 2012). The few studies that did examine the effects on well-being emphasized the emotional component of well-being (Reis et al. 2000; Vansteenkiste et al. 2010), but ignored its physical and psychological dimensions.

Given the theoretical assumptions of SDT, a need-supportive intervention might produce improved levels of subjective health through individuals' attainment of their goals. More specifically, it is assumed that the provision of need-support should be harmonized with one's specific goals, interests and daily activities in order to increase his/her level of well-being (Reis et al. 2000; Ryan and Deci 2000). Consequently, in a population aiming to increase their PA level, a need-supportive PA counseling might enhance their level of well-being through (the attainment of their) PA (goals). Nevertheless, to our knowledge, previous research on need-supportive PA counseling has examined neither the effects on various dimensions of well-being nor the mediating influence of PA on well-being.

A second limitation with respect to research on subjective health is related to the study design. Most study designs on the association between PA and well-being have been cross-sectional, which does not allow the identification of causal relationships (Lampinen et al. 2006). Third, research on the various dimensions of subjective well-being has usually been qualitative (e.g. Ku et al. 2007; Stathi et al. 2002). The few quantitative studies that did focus on the effectiveness of a PA intervention on the different dimensions of well-being (Opdenacker et al. 2008c; Penedo and Dahn 2005) involved short-term follow-up periods and did not consider various intensities of PA.

Taking the abovementioned limitations into account, we set up a longitudinal design with a sufficiently long follow-up period that would allow us to draw conclusions with respect to the long-term causality or direction of the associations between perceived need-support, PA and the different dimensions of well-being. More specifically, this study aimed at: (1) determining whether SDT-based PA counseling enhances (long-term) physical and psychological well-being

among adults who did not attain the recommended PA level for health before the beginning of the intervention but aimed to engage in PA regularly; and (2) establishing whether various intensities of PA mediate these intervention effects. It was hypothesized that physical and psychological well-being would increase in the intervention condition (INTERV) whereas no changes would occur in the control condition (CONTR). Additionally, given that (1) need-supportive programs have been shown to be effective in increasing (in particular higher intensity) PA, (2) PA has been found to enhance subjective well-being, and (3) providing need-support with respect to individuals' personal goals is assumed to improve their well-being, intervention effects on well-being were expected to be mediated by (higher intensity) PA.

Methods

Recruitment and participants

Recruitment procedure

Participants were employees of the university of Leuven (e.g., research assistants, technical workers) who did not attain the recommended level of PA for health as prescribed by the American College of Sports Medicine (Haskell et al. 2007), and who were willing to engage in a four-month PA counseling provided by bachelors in kinesiology (i.e. participants' coach during the intervention). Recruitment occurred through a single personal email and a single announcement in a weekly internal newsletter. The email and announcement were entitled '*Searching for a personal PA coach?*' and included information on the different aspects of the counseling procedure and on the profile of employees that were allowed to participate in the program (i.e. those who were not regularly engaged in PA but who were willing to incorporate more PA in their daily routines). Although the recruitment took place in a work setting, participation in the PA intervention occurred independently of this setting.

Because of the large response rate on the abovementioned announcements, a personal email was sent to each of the volunteers ($n = 382$) in which they were requested to specify their weekly PA pattern. In particular, they were asked to complete a weekly schedule (i.e. time table) on which they had to provide details on the type, duration, intensity, frequency and time frame of the different PA they

performed during a typical week. The completion of the weekly schedule was not part of the pre-test measurements but was only used to provide a general view on the volunteers' PA pattern before their participation in the program. The volunteers that already attained the recommended level of PA as prescribed by Haskell et al. (2007) were not considered as sedentary and were therefore excluded from the study ($n = 36$) (Figure 1). Furthermore, each coach ($n = 30$) was able to provide PA support to three participants. Consequently, the 'first come – first served principle' was applied, meaning that only first responders ($n = 90$) were allowed to participate in the PA intervention. Two participants dropped out shortly after the beginning of the study due to health motives and were replaced immediately, which resulted in 92 participants in INTERV.

Given their interest and willingness to engage in regular PA, the remaining volunteers ($n = 254$), i.e. those who did not attain the recommended PA level but who responded too late (relatively to the first responders) to be included in INTERV, received a booklet with practical information of the different PA opportunities organized by the sports center of the university such as aerobic classes, fitness, swimming, badminton, marked walking routes in the environment etc. Moreover, they were given priority to participate in the PA counseling program during the following academic year on condition that they completed PA-related questionnaires twice during the next four months, i.e. at pre-test and post-test measurements. In this respect, they would be included in a waiting-list CONTR. In total, 34 employees decided to participate in CONTR.

Drop-out

Drop-out rates in INTERV and CONTR immediately after the intervention (i.e. at post-test) were 6.5% and 0.0% ($\chi^2 = 2.261, p = .152$), respectively; Drop-out rates one year after the intervention (i.e. at follow-up-test) compared with pre-tests were respectively 13.0% and 11.8% ($\chi^2 = 0.019, p = .580$). A lack of motivation was the most frequently reported reason for dropping out. Demographic variables, well-being and PA did not differ significantly between drop-outs and adherers in INTERV and CONTR, indicating a non-selective study drop-out with respect to these variables.

Procedures and intervention

PA coaches

Coaches were bachelors in kinesiology specializing in health-related PA counseling. During an eight-hour course in psychology of behavioral motivation and PA promotion, the theoretical background of behavior change and need-supportive counseling was studied in depth. In addition to mastering the theory, the students improved their coaching proficiency by role playing, in which they learned to translate the theoretical principles into real-life situations. The student-coaches were especially trained in PA counseling according to SDT, motivational interviewing and applying behavioral change techniques. During the course, they received individual feedback, tips and tricks continuously from their professor in exercise and sport psychology and from Health Fitness Specialists (MSc) who were experienced in need-supportive counseling.

Before the PA counseling, i.e. at the end of the course, the students were tested on their theoretical knowledge and their ability to apply the theory in a practical situation. An additional evaluation was planned immediately after the first contact moment between coach and client in order to discuss difficulties, to clear up ambiguities and to deal with problems instantaneously. During the counseling period, the student-coaches were encouraged to make use of an online forum on which they could share their experiences with, and announce difficulties, ask questions and provide useful information to other students. By informing the professor and reflecting on the progress of their counseling after each contact moment with their client, the student-coaches were supervised thoroughly and problems could be solved immediately.

Counseling procedure

After recruitment, five individual contact moments occurred between coach and participants of INTERV. The amount of time between the different contact moments varied from three weeks at the beginning of the PA counseling to five weeks at the end of the PA counseling.

During a one-hour face-to-face intake session, participants of INTERV formulated several PA goals taking into account their PA history, preferences and abilities. The coach aimed to help and support the client to set up a realistic and appropriate PA plan. For example, engaging in PA in which individuals' body is carried such as cycling might have been an appropriate PA for participants who

were overweight; Engaging in PA in which individuals have to play against opponents such as badminton or volleyball might have been appropriate for participants who were involved in team sports in their childhood. In this respect, the coach explored PA options in collaboration with the client. However, in the end, the client decided him/herself which type, frequency and intensity of PA he/she was willing to perform. Accordingly, the coach acted as a facilitator rather than a prescriber of PA. The goals, which were specified by PA type, location, time frame, company, possible barriers and solutions, were written down in an individual weekly schedule. The main objective of the PA intervention was to support the participants to attain the recommended level of PA for health as prescribed by Haskell et al. (2007).

During the intake session, the coaches explicitly fostered the three basic psychological needs outlined by SDT, i.e. the need for autonomy, the need for competence and the need for relatedness. Given that the need for autonomy refers to individuals' desire to be the origin of their own behavior and accordingly, involves a sense of choice, personal control and self-endorsement, the coach applied the following strategies to satisfy this need: focusing on task-oriented rather than ego-oriented goals, encouraging individuals to initiate actions for their own reasons, minimizing pressure by using autonomy supportive language (e.g., pronouncing 'may' instead of 'must'), acknowledging individuals' perspective, providing informational feedback and a meaningful rationale for given advice, and using client-centered strategies such as exploring options. The need for competence, which implies individuals' pursuit of experiencing mastery and success within a challenging environment, was fulfilled by providing structure, helping individuals to develop clear expectations, formulating challenging but realistic goals in collaboration with the individual, identifying barriers and drafting a plan to solve them, pronouncing positive feedback, and reinforcing self-motivational statements. Finally, the PA coaches supported participants' need to interact with, to be related and connected to, and to feel a sense of belongingness for other individuals by demonstrating understanding, showing unconditional regard, using non-judgmental and positive language, and creating an empathic, warm and positive atmosphere (e.g., by active listening).

In addition to the need-supportive counseling, the coaches applied the following three behavior change techniques: planning (i.e. helping the participants

to fit the PA goals in their daily schedule), barrier identification (i.e. identifying PA barriers and planning ways to overcome them) and suggesting prompts and cues (i.e. teaching the participants to identify environmental cues that can be used to remind them to perform PA) (Abraham and Michie 2008).

After the intake session, three follow-up contacts took place in which participants were supported through face-to-face contacts, booster phone calls or email. Given that each of these methods have been shown to be effective in behavioral change (Opdenacker and Boen 2008a; Portnoy et al. 2008), the way in which participants were contacted was in line with their preferences. During follow-up contact, the coaches motivated the participants to persist in their PA, relying on SDT-based coaching and motivational interviewing. Moreover, adherence was evaluated, PA goals were modified if necessary, and participants were praised for their effort and performance.

One face-to-face outtake session was scheduled to evaluate the participants' behavioral change, to make sure the participants mastered the required techniques to continue their PA engagement after the intervention, and to discuss future challenges. After the outtake session, there was no contact anymore between coach and participant. Moreover, participants were not informed on the occurrence of year-round follow-up-test measurements until one year after pre-tests. More specifically, at this moment, they were sent a letter in which they were asked to complete the follow-up-test questionnaires in order to provide information on their current PA pattern and well-being.

Participants of INTERV completed measurements at pre-test (i.e. at the beginning of the intake session), at post-test (i.e. at the beginning of the outtake session) and at follow-up-test (i.e. one year after the beginning of the intervention) under the supervision of their coach. Participants of CONTR did not receive any PA instruction or counseling. They completed pre-, post- and follow-up-tests in the same time period as INTERV and under the supervision of a Health Fitness Specialist (MSc). The study was approved by the Ethical Committee of the university.

Measurements

Well-being

Various dimensions of subjective well-being were measured by the Louvain Well-Being Scale from Marcoen and colleagues (2002). Consistent with previous research on subjective health among Flemish adults (Opdenacker et al. 2008c; Raepsaet et al. 2010) and given the close association between PA on the one hand and physical and mental health on the other hand, only on the physical and psychological dimensions of well-being were evaluated in this health-oriented intervention. Four items were selected out of the physical well-being subscale and four items were selected out of the psychological well-being subscale. This selection was based on factor loadings and internal consistency scores (Opdenacker et al. 2008c). Physical well-being asks for physical health as well as for happiness and acceptance of one's body (e.g., I am satisfied with my body). Psychological well-being refers to the satisfaction with oneself and one's life (e.g., I am happy with the person I am). Participants indicated how frequently they agreed with the given statement on a seven-point Likert scale, ranging from '1 = never' to '7 = always'. Cronbach's alpha coefficients for pre-, post- and follow-up-tests ranged from .67 to .84, indicating good to very good internal consistency.

PA

PA was assessed with a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ) (Godin and Shephard 1985). This brief questionnaire is considered to be clearly comprehensible and has been frequently employed in Western populations (e.g. De Bacquer et al. 2010; Edmunds et al. 2006). Participants were asked for the number of times that they engaged for at least 20 minutes in mild, moderate and strenuous intensity PA in a typical week during the past month. The reported frequencies were weighted by metabolic equivalents for each intensity category, i.e. three, five and nine respectively, and summed to obtain an overall measure of PA. Adequate validity and test-retest reliability of GLTEQ have been demonstrated previously (Godin and Shephard 1985; Jacobs et al. 1993).

The applied questionnaire differed from the original questionnaire with respect to the following two aspects: (1) Given that active transport such as walking and cycling is popular among the Flemish population, participants were asked for the number of times that they engaged in PA each week not only during their free time but also for transportation (Scheerder et al. 2011); and (2) In order

to easily translate the reported frequencies on the GLTEQ to the recommended PA level for health as prescribed by Haskell et al. (2007), participants were asked for the number of times that they engaged in PA each week for 20 minutes or more instead of 15 minutes or more. According to Scheerder et al. (2011), an overall score of 27 on GLTEQ corresponds with the recommended PA level of performing 20 minutes of strenuous PA on at least three days a week.

Perceived need-support of the coach

Participants' perceived need-support of the PA coach was measured by a modified version of the Teacher As Social Context Questionnaire (Belmont et al. 1988), which was originally developed to evaluate need-support within a school context. This questionnaire has been applied in previous research among Western populations (e.g. Sierens et al. 2009; Vansteenkiste et al. 2009) and assesses the three dimensions of coaches' behavior as proposed by SDT, i.e. autonomy support (eight items; e.g., 'My coach listens to my opinion and ideas'), competence support (eight items; e.g., 'My coach shows me how to solve problems for myself') and relatedness support (eight items; e.g., 'My coach really cares about me'). The questionnaire on perceived need-support was only completed after the intervention (i.e. at post-test) and by participants of INTERV. They were asked to indicate their agreement with the items on a five-point Likert scale, ranging from '1 = completely disagree' to '5 = completely agree'. Cronbach's alpha coefficients for autonomy support, competence support, relatedness support and perceived need-support in general were respectively .79, .85, .84 and .92, indicating very good internal consistency.

Data analysis

Data were analyzed using SPSS 16.0 (SPSS Inc, Chicago, IL, USA). Differences between INTERV and CONTR were assessed by one-way ANOVAs for continuous measures and chi-square-tests (χ^2) for categorical measures. Intervention effects on well-being were conducted with repeated measurements ANOVAs. Indirect effects of the intervention on changes in well-being through changes in various intensities of PA in INTERV were tested by the bootstrapping procedure described by Preacher and Hayes (2008). This method does not make assumptions on the shape of sampling distribution of the indirect effect (Preacher

and Hayes 2008). Bias-corrected confidence intervals of the indirect effects were generated with 2000 resamples. In order to determine which intensity of PA was most successful in explaining variances in well-being, (change scores of) mild, moderate and strenuous PA were included simultaneously in a multiple mediator model. Mediation analyses were conducted in the short term (i.e. from pre- to post-test) and in the long term (i.e. from pre- to follow-up-test). One person was excluded from all analyses because the pre-test GLTE-score exceeded three standard deviations from the pre-test mean score. Significance level was set at $p < .05$.

Results

Demographic profile

Table 1 displays the demographic characteristics of the participants of INTERV and CONTR at pre-test. No significant differences emerged between both conditions for these variables.

Effects on well-being

INTERV and CONTR did not differ significantly with respect to physical and psychological well-being at pre-test (physical well-being: $F = 0.231$, $p = .632$; psychological well-being: $F = 0.112$, $p = .739$). However, significant 3 (time) $\times$ 2 (conditions) interaction effects on physical well-being indicated that both conditions changed differently over time (Table 2). A more detailed description of the changes in well-being in the short term (i.e. from pre- to post-test) and in the long term (i.e. from pre- to follow-up-test) is provided below.

From pre- to post-test

Physical well-being changed differently over time in INTERV and CONTR from pre- to post-test. More specifically, INTERV improved their level of physical well-being ($F = 57.113$, $p = .000$, $\eta^2 = .402$), whereas no changes emerged in CONTR ($F = 3.980$, $p = .055$, $\eta^2 = .111$). Consequently, higher post-test levels of physical well-being were found in INTERV compared with CONTR ($F = 7.238$, $p = .008$). Contrary to physical well-being, psychological well-being did not change

significantly from pre- to post-test in INTERV or CONTR (INTERV: $F = 1.747$, $p = .190$, $\eta^2 = .120$; CONTR: $F = 0.396$, $p = .534$, $\eta^2 = .012$).

From pre- to follow-up-test

A borderline significant 2 (time) by 2 (conditions) interaction effect was found in physical well-being ($F = 3.341$, $p = .070$, $\eta^2 = .030$). More specifically, physical well-being increased significantly in INTERV ($F = 11.921$, $p = .001$, $\eta^2 = .131$), whereas no changes occurred in CONTR ($F = 0.001$, $p = .974$, $\eta^2 = .000$).

Consequently, INTERV showed significantly higher levels of well-being at follow-up-test compared with CONTR ($F = 8.080$, $p = .005$).

With respect to psychological well-being, a significant decrease was found in both conditions from pre- to follow-up-test (INTERV: $F = 4.713$, $p = .033$, $\eta^2 = .056$; CONTR: $F = 6.543$, $p = .016$, $\eta^2 = .189$). However, pre- to follow-up-test changes in psychological well-being were not significantly different between INTERV and CONTR ($F = 1.357$, $p = .247$, $\eta^2 = .013$). This indicates that, in the long term, psychological well-being was not affected by the PA intervention.

Individuals' changes in well-being

Irrespective of the average degree to which INTERV and CONTR changed in well-being, one-way ANOVAs were conducted in order to examine whether individuals' tendency to improve or reduce their level of well-being was influenced by their initial level of well-being. It was shown that participants who improved their subjective well-being reported lower pre-test levels of well-being than participants who did not improve their level of well-being. This tendency was found for both dimensions of well-being, and in the short as well as in the long term (from pre- to post-test: physical well-being: $F = 12.061$, $p = .001$; psychological well-being: $F = 5.024$, $p = .027$; from pre- to follow-up-test: physical well-being: $F = 31.376$, $p = .000$; psychological well-being: $F = 6.657$, $p = .011$).

Mediation through PA

Table 3 displays the mediation effects of various intensities of PA on physical well-being in INTERV. Given that the intervention did not affect psychological

well-being, mediation analyses were not conducted with respect to this dimension of subjective well-being.

From pre- to post-test

The significant α -paths indicate an intervention effect on pre- to post-test changes in moderate and strenuous PA. This means that INTERV increased more in moderate and strenuous PA from pre- to post-test than CONTR. The overall intervention effects on mild, moderate, strenuous and total PA are displayed in Table 4 and described in detail in Van Hoecke et al. (2012). Furthermore, significant direct effects from changes in strenuous PA to changes in physical well-being (β -paths) demonstrate that the more participants increased in strenuous PA from pre- to post-test, the more they increased in physical well-being from pre- to post-test. Finally, the confidence intervals of the indirect $\alpha\beta$ -pathways via the proposed mediators (i.e. changes in mild, moderate and strenuous PA) show that pre- to post-test changes in strenuous PA contributed significantly to the pre- to post-test changes in physical well-being. The significant direct intervention effect on physical well-being became non-significant when controlling for the proposed mediators, indicating full mediation. The overall multiple mediator model accounted for 16.1% ($F = 5.545, p = .001$) of the variance in pre- to post-test changes in physical well-being.

From pre- to follow-up-test

The mediating influence of PA on well-being in the long term was similar to the mediating influence in the short term. More specifically, a significant intervention effect on changes in strenuous PA (α -paths) and a significant β -path from changes in strenuous PA to changes in physical well-being were identified. Furthermore, pre- to follow-up-test changes in strenuous PA contributed to the indirect intervention effect on pre-to follow-up-test changes in physical well-being ($\alpha\beta$ -paths). In addition to the similarities with the pre- to post-test results, pre-to follow-up-test changes in mild PA contributed significantly to the intervention effect on changes in physical well-being. The multiple mediator model with pre- to follow-up-test changes in mild, moderate and strenuous PA as proposed mediators explained 11.2% ($F = 3.273, p = .014$) of the variance in pre-to follow-up-test changes in physical well-being.

The recommended PA level and well-being

Given the mediating influence of (strenuous) PA on well-being, one-way ANOVAs were conducted to examine the relation between attaining the recommended PA level and participants' level of and improvement in subjective well-being. More specifically, it was tested whether high levels of well-being corresponded with an overall score of 27 on GLTEQ, and thus with the recommended level of PA for health as prescribed by Haskell et al. (2007), i.e. performing 20 minutes of strenuous PA three times a week. It was shown that participants who attained a GLTE-score of at least 27 perceived higher levels of physical well-being compared with those who did not attain a GLTE-score of 27 ($F = 5.913, p = .017$). Moreover, participants who attained the recommended PA level at follow-up-test (i.e. scored 27 or more on the GLTEQ) were also those who improved their level of physical well-being from pre- to follow-up-test ($\chi^2 = 6.780, p = .008$).

Perceived need-support

After the intervention, participants of INTERV indicated a mean score of 4.422 ± 0.388 on a five-point Likert scale for perceived need-support in general. With respect to the different dimensions of need-support, the following mean scores were found: 4.540 ± 0.384 for autonomy support, 4.438 ± 0.446 for competence support, and $4.287 \pm .509$ for relatedness support. Subsequent analyses indicated that 3.380 was the minimum score on perceived need-support and revealed that 87.0% of the participants scored four or more on a five-point Likert scale with respect to perceived need-support.

Discussion

The results of this study demonstrated the effectiveness of a four-month need-supportive PA counseling on the physical dimension of subjective well-being. More specifically, INTERV showed significant increases in physical well-being, whereas no changes occurred in CONTR. The improvement in well-being after the intervention is consistent with literature on the effectiveness of various PA programs on physical health and well-being (e.g. Anderson et al. 2005; Lloyd and Little 2010; Opdenacker and Boen 2008a; Wilson et al. 2003). At the same

time, the positive influence on the physical component of well-being in the long term is remarkable given that studies examining sustained PA effects on subjective health and well-being produced rather inconsistent results (e.g. DiLorenzo et al. 1999; Fox et al. 2007; Hicks et al. 2003; McAuley and Rudolph 1995).

Besides showing the long-term effectiveness of a PA program on well-being, this study extended previous research by demonstrating the effectiveness of a PA program that is need-supportive on well-being. In particular, results indicated that sedentary adults who aimed to increase their PA level obtained positive changes in physical well-being due to a PA counseling in which the three basic psychological needs were fostered. In this respect, it is suggested that the perception of physical well-being among individuals who are motivated to engage in PA can be improved by a PA coach who (1) supports individuals' need for autonomy by providing personal control on their PA goals, minimizing pressure, and pronouncing a meaningful rationale for given advice, (2) supports individuals' need for competence by formulating a structured and appropriate PA plan, drafting solutions for identified PA barriers, and giving positive feedback, and (3) supports individuals' need for relatedness by creating meaningful interpersonal relationships within an empathic environment.

The need-supportive character of the PA intervention is demonstrated by the relatively high scores on the different dimensions of perceived need-support at post-test, i.e. 4.287 or more on a five-point Likert scale. However, in addition to the need-supportive character of the counseling procedure, the following two aspects might have contributed to these high rates on need-support in INTERV: (1) The application of the 'first come – first served principle'. Given that only a limited number of volunteers were allowed to participate in the PA program, the participants might have been grateful and pleased they got the chance to be counseled by a bachelor (i.e. an expert) in kinesiology. In this respect, every encouraging contact during the counseling procedure was probably experienced as positive and need-supportive, especially given that the participants were highly motivated to increase their PA level; (2) The PA counseling as part of the educational curriculum of the bachelors in kinesiology. The educational purpose of the need-supportive PA counseling, which also entails that the counseling was free of charge, might have led the participants to be cooperative towards the

student-coaches and to evaluate them rather positively. However, even though the scores on perceived need-support might have been to some extent overestimated, the sustained improvements in physical well-being one year after the intervention demonstrate the positive influence of need-supportive PA counseling on well-being. Moreover, the demonstrated improvements in the long term strengthen the contribution of the SDT-based counseling to the increases in subjective health relative to possible participation effects.

In addition to examining the effectiveness of a need-supportive PA program on subjective well-being, we evaluated the mediating influence of various intensities of PA. As hypothesized, pre- to post-test and pre- to follow-up-test changes in (higher intensity) PA contributed to changes in (physical) well-being in INTERV. These results are consistent with SDT-based assumptions and suggest that providing need-support with respect to the pursuit and attainment of one's personal goals enhances the person's well-being (Ryan and Deci 2000). The finding that mainly strenuous PA contributed to the intervention effects on well-being highlights the importance of differentiating between various intensities of PA. The role of higher intensity PA in improving well-being can be explained by two processes. (1) A cognitive process. Higher intensity PA is considered to be more purposeful and structured than mild PA (e.g., aerobic classes versus active transport, respectively). Consequently, the higher the intensity of performed PA, the higher the required level of cognitive processing (Edmunds et al. 2006; Silva et al. 2010b). Given that the intervention involved a theoretically grounded need-supportive PA counseling procedure, and thus required a sufficient level of cognitive functioning, mainly higher intensity PA increased in INTERV (Van Hoecke et al. 2012); (2) A physiological process. The causal relationship between changes in strenuous PA and changes in physical well-being points out that the higher the intensity of PA in which people are participating, the more they are susceptible to perceive the positive outcomes on the physical dimension of well-being. This finding is in line with earlier research indicating that higher intensity PA is more beneficial to improve physical fitness, health and well-being than lower intensity PA (e.g. Norris et al. 1992; Swain and Franklin 2006). Physical fitness and health are both considered to be important elements of the physical component of well-being and quality of life (Pristed et al. 2012; Stathi et al. 2002; Thøgersen-Ntoumani et al. 2005). Accordingly, it appears that the sustained

effects on physical well-being in the long term can be explained by the long-term effects on strenuous PA; As long as one succeeds in persisting in high intensity PA, improved feelings of physical fitness, and thus higher levels of physical well-being, will be maintained. The close association between higher intensity PA and physical well-being is also confirmed by subsequent analyses pointing out that participants who increased their higher intensity PA were also those who increased their level of physical well-being.

From pre- to follow-up-test, the need-supportive PA counseling procedure yielded increases in physical well-being not only through increases in strenuous PA but also through increases in mild PA. This means that, in the long term, mild PA contributed to the variance in well-being as well. The integration of low intensity PA (e.g., active transportation) in participants' daily life might have resulted from their increases in higher intensity PA. More specifically, the more participants engage in higher intensity PA (e.g., dance classes), the more they improve their physical fitness and the less effort low intensity PA requires. Moreover, the contribution of mild PA to well-being suggests that, in the long term, low intensity and thus habitual PA were perceived as self-determined as well.

Overall, the results of this intervention suggest that it is important for individuals to increase their high intensity PA level, for coaches to facilitate individuals' needs for autonomy, competence and relatedness with respect to their PA goals, and for policy makers to support SDT-based PA interventions in order to obtain subjective health benefits in the population. In particular, individuals and policy makers should be informed on the importance of attaining the recommended level of PA for health as prescribed by Haskell et al. (2007) in order to improve individuals' perception of physical well-being.

The strong association between physical well-being and PA also emphasizes the broad ranging character of physical well-being in that it involves more than avoiding diseases and disabilities (Reis et al. 2000; Stathi et al. 2002). It refers to the experience of a good health, the increase in physical fitness, the satisfaction with one's body, perceived vitality and the ability to perform habitual tasks without effort (Ku et al. 2007; Stathi et al. 2002). Those physical aspects of well-being are probably perceived shortly after one has increased his/her (high intensity) PA level. This reasoning is in accordance with earlier research (Rejeski

et al. 2001; Stathi et al. 2002) in which was stated that functional changes are the most direct and salient effects experienced through involvement in PA programs.

At the same time, the findings underline the multidimensional character of well-being. Previous studies established the key role of PA in enhancing mental health, perceiving higher levels of happiness and obtaining a feel-good effect (e.g. DiLorenzo et al. 1999; Fox 1999; Opdenacker et al. 2008c; Stathi et al. 2002). However, in contrast with our hypotheses and despite the well-pronounced improvements in physical well-being, no intervention effects emerged on the psychological component of well-being. The lack of positive changes in psychological well-being can be explained by two reasons. First, the relatively high baseline score of psychological well-being, i.e. 5.6 on a seven-point Likert scale, suggests that the participants were initially already happy and satisfied with their lives. Consequently, further improvements in psychological well-being were less likely to occur than in physical well-being, which had a substantially lower score at baseline, i.e. 4.2 on a seven-point Likert scale. Given that participants were employees, the high level of psychological well-being is in accordance with Keyes and Waterman (2003) who recognized employment as a determinant of subjective well-being, happiness and mental health. Second, there is a clear difference in meaning between the items of the physical well-being subscale and the items of the psychological well-being subscale. More specifically, while the items of the physical well-being subscale refer to individuals' physical health, body perception and physical fitness, the items of the psychological well-being subscale refer to how people feel 'in general'. Given the physical aspect of (high intensity) PA, participants were probably more likely to perceive positive changes in their physical well-being than in their psychological well-being. Even though the participants might have felt happy and psychologically satisfied when attaining their PA goals, other factors than the pursuit of PA goals might be crucial to yield positive changes in psychological well-being and quality of life (e.g., social reasons, enjoyment, work-related aspects).

Nevertheless, as assumed by SDT, the overall reported results point out the effectiveness of providing need-support in enhancing particular dimensions of subjective well-being through the pursuit and attainment of one's goals. Need-supportive PA counseling might therefore be considered as a promising health promoting strategy among sedentary adults aiming to increase their PA level.

Furthermore, the results indicated that such an intervention is especially appropriate for individuals with initially lower levels of well-being. Interventions should thus focus mainly on this population segment in order to improve public health through PA promotion.

Before concluding, strengths and limitations should be noted. The use of a longitudinal design constitutes a first strength as it allowed us to examine causality between need-supportive counseling, PA and well-being rather than studying cross-sectional associations. Moreover, this study focused on the effectiveness in the long term, which is in line with SDT-based assumptions. Second, given that well-being is associated with PA on the one hand and with need-satisfaction on the other hand, mediation effects of PA on well-being were examined. This enabled us to gain insight in the extent to which increased PA contribute to improved well-being. Third, by acknowledging the physical and psychological components of subjective well-being, we were informed on the influence of PA on the different dimensions of well-being. Fourth, notwithstanding the individual character of the contact between coach and participant, the limited number of contact moments facilitates the implementation of such a PA intervention at community level. Moreover, the potential to implement this health-promoting program at a large scale is supported by the number of coaches applied in this study ($n = 30$) as well as the relatively condensed course that was provided to them in order to obtain satisfactory coaching proficiencies with respect to SDT and motivational interviewing. Fifth, the inclusion of CONTR strengthens the positive effects of the need-supportive PA intervention on subjective well-being.

At the same time, the recruitment of CONTR constitutes the main limitation. Due to ethical, educational and social reasons, the ‘first come – first served principle’ was applied. This recruitment procedure entails the lack of a strict randomization between INTERV and CONTR. Nevertheless, no significant baseline differences were identified between both conditions with respect to demographic variables, well-being, motivation to PA engagement, and low to moderate intensity PA. Moreover, given that 94% of the volunteers responded within 24 hours after the time the announcements were made, no bias concerning assignment to INTERV and CONTR was assumed by applying the ‘first come – first served principle’.

The volitional character of participation can be considered as a second limitation. The sample consisted of adults motivated to increase their PA level, which might have contributed to the positive effects of the counseling. This self-selection process hampers the generalizability of the findings to a less motivated population. Furthermore, the probably high motivation of all initial volunteers to increase their PA may also have led to the unequal number of participants in INTERV and CONTR. The majority of the volunteers responded to the announcement within one day, which reflects their willingness to be counseled in their PA. Accordingly, the volunteers who were not included in INTERV because of their late reply relatively to the first responders, were probably willing to engage in PA immediately and thus to make use of other PA opportunities than the PA counseling.

Third, PA measurements were based on self-reports, which can have led the participants to overestimate their PA level, to inaccurately interpret some of the questionnaires or to produce social desirable answers. However, subjective measures of health have been shown to be more strongly related to outcomes such as life satisfaction than are objective health indices (Rejeski and Mihalko 2001).

Fourth, the use of a modified and shortened version of the Louvain-Well-Being Scale of Marcoen and colleagues (2002) reduces the generalizability of the results to other dimensions of well-being and to subjective well-being in general. However, the main purpose of this intervention was to improve individuals' health and well-being through an increase of their PA level. Given that PA is closely related to physical and mental health, only the physical and psychological dimensions of subjective well-being were assessed.

Fifth, applying 30 counselors may have increased the variety with respect to the PA counseling, and consequently may have reduced the coaching consistency among the coaches. However, the students were educated and instructed sufficiently, were supported by experienced Health Fitness Specialists (MSc), and received feedback from their professor and other student-coaches. Accordingly, the student-coaches were well-prepared to fulfill their role as a need-supportive PA counselor appropriately, and to provide high-quality coaching. Moreover, the relatively high score on perceived need-support after the intervention, i.e. 4.420 on a five-point Likert scale with a minimum score of 3.380, suggests that each of the student-coaches has provided PA counseling in a

need-supportive and satisfactory way. Furthermore, the finding that a PA intervention applied by a large number of coaches (and thus with more room for interpretation of the theoretical principles) yielded positive changes in the long term even strengthens the results of this study and enlarges the potential to implement such a health-promoting program at a large scale.

In conclusion, the results partially supported our hypotheses and provide evidence for the year-round effectiveness of need-supportive PA counseling with a limited number of contact moments in improving physical well-being through strenuous PA. Accordingly, the promotion of high intensity PA through SDT-based coaching might be beneficial to increase well-being and quality of life at community level, especially among adults with initially lower levels of well-being.

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Table 1 Means (SD) or percentages for demographic characteristics of INTERV and CONTR at pre-test.

Characteristic	INTERV (<i>n</i> = 92)	CONTR (<i>n</i> = 34)	<i>F</i> or χ^2	<i>p</i>
Age (years)	41.480 (13.335)	40.820 (14.655)	0.056	.813
Male (%)	52.2	51.5	0.004	.554
Married or living together with partner (%)	68.5	78.8	1.259	.186
Body Mass Index (kg/m ²)	24.991 (4.238)	24.449 (3.528)	0.433	.512
Function at KU Leuven (%)			10.446	.064
Professor	19.6	24.2		
Research assistant	33.7	45.5		
Technical employee	30.4	18.2		
Emeritus professor	3.3	6.1		
Other (e.g., partner of employee)	13.0	6.1		

SD, standard deviation; INTERV, intervention condition; CONTR, control condition.

Table 2 Means (SD) at pre-test, post-test and follow-up-test for physical and psychological well-being in INTERV and CONTR, 3 (time) x 2 (conditions) interaction effects and 2 (time) x 2 (conditions) interaction effects from pre- to post-test and from pre- to follow-up-test.

INTERV	CONTR	3 (time) x 2 (conditions) INTERACTION		2 (time) x 2 (conditions) INTERACTION	
		<i>F</i>	η^2	<i>F</i>	η^2
Mean (SD)	Mean (SD)				

Physical WB	Pre	4.284 (0.886)	4.197 (0.910)	3.955 *	.037
	Post	4.945 (0.827)	4.466 (0.972)		5.573 * .045
	Fu	4.678 (0.678)	4.220 (0.905)		3.341 £ .030
Psychological WB	Pre	5.614 (0.676)	5.568 (0.683)	1.767	.017
	Post	5.698 (0.730)	5.500 (0.650)		1.540 .013
	Fu	5.470 (0.784)	5.285 (0.755)		1.357 .013

SD, standard deviation; INTERV, intervention condition; CONTR, control condition; WB, well-being; Pre, value of well-being at pre-test; Post, value of well-being at post-test; Fu, value of well-being at follow-up-test; 3 x 2 INTERACTION, interaction effect over time (3) and between conditions (2) for physical and psychological well-being; 2 x 2 INTERACTION, interaction effect over time (2; i.e. from pre- to post-test or from pre- to follow-up-test) and between conditions (2) for physical and psychological well-being; *, $p < .05$; £, $p = .07$.

Table 3 Mediation effects of changes in physical activity on changes in physical well-being.

	α -path	β -path	$\alpha\beta$ -path	95% CI of $\alpha\beta$	
	coefficient (SE)	coefficient (SE)	coefficient (SE)		
Pre- to post-test					
Δ prepo physical WB					
Δ prepo mild PA	- 0.129 (0.499)	0.057 (0.029)	- 0.007 (0.032)	- 0.090	to 0.044
Δ prepo moderate PA	- 1.201 (0.500) *	0.026 (0.030)	- 0.031 (0.035)	- 0.115	to 0.027
Δ prepo strenuous PA	- 0.948 (0.251) ***	0.205 (0.060) ***	- 0.195 (0.071)	- 0.373	to - 0.087
Multiple mediator model			- 0.233 (0.088)	- 0.424	to - 0.076
Pre- to follow-up-test					
Δ prefu physical WB					
Δ prefu mild PA	- 1.066 (0.594)	0.043 (0.028)	- 0.046 (0.035)	- 0.149	to - 0.001
Δ prefu moderate PA	- 1.080 (0.712)	0.027 (0.023)	- 0.030 (0.035)	- 0.136	to 0.013
Δ prefu strenuous PA	- 0.701 (0.290) *	0.133 (0.057) *	- 0.093 (0.058)	- 0.247	to - 0.009
Multiple mediator model			- 0.169 (0.069)	- 0.325	to - 0.056

WB, well-being; PA, physical activity; Δ prepo, change score from pre- to post-test; Δ prefu, change score from pre- to follow-up-test; α , estimate of the intervention effect on changes in the proposed mediators; β , estimate of the direct effect of changes in the proposed mediators on changes in well-being while controlling for the intervention effect; $\alpha\beta$, estimate of the indirect intervention effect on changes in well-being through the proposed mediators; 95% CI, 95% bias-corrected confidence interval with the empirically derived bootstrapped sampling distribution of $\alpha\beta$ (result of 2000 bootstrap resamples); *, $p < .05$; **, $p < .01$, ***, $p < .001$.

Table 4 Means (SD) at pre-test, post-test and follow-up-test for mild, moderate and strenuous physical activity in INTERV and CONTR, 3 (time) x 2 (conditions) interaction effects and 2 (time) x 2 (conditions) interaction effects from pre- to post-test and from pre- to follow-up-test.

		INTERV	CONTR	3 (time) x 2 (conditions) INTERACTION		2 (time) x 2 (conditions) INTERACTION	
		Mean (SD)	Mean (SD)	<i>F</i>	η^2	<i>F</i>	η^2
Mild PA	Pre	1.007 (1.752)	1.345 (1.738)	1.952	.018		
(times a week for ≥ 20 minutes)	Post	1.214 (2.332)	1.448 (2.422)			0.067	.001
	Fu	1.831 (2.380)	1.103 (1.566)			3.228	.029
Moderate PA	Pre	0.916 (1.635)	1.379 (1.374)	2.122	.020		
(times a week for ≥ 20 minutes)	Post	2.370 (2.751)	1.767 (2.009)			5.765 *	.047
	Fu	2.896 (3.336)	2.155 (3.410)			2.302	.021
Strenuous PA	Pre	0.224 (0.558)	0.655 (1.045)	5.882 **	.054		
(times a week for ≥ 20 minutes)	Post	1.175 (1.248)	0.647 (0.930)			14.291 ***	.109
	Fu	1.065 (1.306)	0.776 (0.960)			5.852 *	.052
Total PA	Pre	9.614 (9.579)	16.828 (12.723)	8.998 ***	.080		
(GLTE-score)	Post	26.071 (14.788)	19.000 (15.695)			23.277 ***	.166
	Fu	29.558 (20.896)	21.069 (21.570)			9.849 **	.084

PA, physical activity; INTERV, intervention condition; CONTR, control condition; GLTE-score, PA score obtained by the Godin Leisure-Time Exercise Questionnaire; SD, standard deviation; Pre, pre-test value; Post, post-test value; Fu, follow-up-test value; 3 x 2 INTERACTION, interaction effect over time (3) and between conditions (2) for mild, moderate, strenuous and total physical activity; 2 x 2 INTERACTION, interaction effect over time (2; i.e. from pre- to post-test or from pre- to follow-up-test) and between conditions (2) for mild, moderate, strenuous and total physical activity; *, $p < .05$; **, $p < .01$; ***, $p < .001$.

Figure 1. Flowchart of the study. PA, physical activity; INTERV, intervention condition; CONTR, control condition.