The Relationships of Change in Physical Activity with Change in Depression, Anxiety, and Burnout: A Longitudinal Study of Swedish Healthcare Workers

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Abstract

Objective: The purpose of the present study was to examine whether intra-individual changes in physical activity were correlated with intra-individual changes in mental health (depression, anxiety, and burnout) across four measurement time-points over 6 years, both from between-person and within-person perspectives.

Methods: Health care workers (N = 3717; mean age = 46.9; SD = 10.0) were the target population in this study, which is part of a larger longitudinal survey that included questionnaires on physical activity levels and mental health (depression, anxiety, and burnout) at four time points across 6 years (2004-2010). Physical activity was assessed with an adapted version of the widely used one-item, four-level Saltin Grimby Physical Activity Level Scale (SGPALS). Depression, anxiety, and burnout were assessed using the Hospital Anxiety and Depression (HAD) scale and the Shirom-Melamed Burnout Questionnaire (SMBQ). Bivariate latent growth curve models were used to analyze the associations of change between physical activity and mental health.

Results: Baseline levels of physical activity were moderately associated with baseline levels of mental health (rs = -.27 to -.40, ps < .01). Changes in physical activity were moderately to strongly associated (rs = -.57 to - .79, ps <. 01) with change in mental health at the between-person (correlated change) level and significantly, but weakly (rs = -.08 to -.14, ps <.01), associated with change at the within-person (coupled change) level of analysis.

Conclusions: Changes in physical activity were associated with, and travelled together with, changes in depression, anxiety, and burnout across time. Changes in physical activity, and not only current or previous levels of activity, may be important to consider in preventive work linked to mental health within this population.

Keywords: physical activity, depression, anxiety, burnout, change, longitudinal analysis

The Relationships of Change in Physical Activity with Change in Depression, Anxiety, and Burnout: A Longitudinal Study of Swedish Healthcare Workers

The potential of physical activity as a means of alleviating the negative health consequences and preventing mental disorders in high stress populations has been discussed since the early 1980s (Biddle, Fox, & Boutcher, 2000; Faulkner & Taylor, 2005). Although there are many studies testing the relationship between physical activity and symptoms of depression (e.g., Jonsdottir, Rodjer, Hadzibajramovic, Borjesson, & Ahlborg, 2010; Strawbridge, Deleger, Roberts, & Kaplan, 2002; Wang et al., 2011) and anxiety (De Moor, Beem, Stubbe, Boomsma, & De Geus, 2006; Goodwin, 2003), research on the interplay between physical activity and burnout is limited. We have previously shown in two different populations that levels of physical activity are negatively related to symptoms of burnout (Jonsdottir et al., 2010; Lindwall, Ljung, Hadzibajramovic, & Jonsdottir, 2012). Burnout may arise as a consequence of work-related psychosocial stress. Stress has been shown to be a major problem for healthcare workers (Stansfeld & Candy, 2006), and it is therefore of great interest to examine how changes in burnout may be related to changes in lifestyle factors such as physical activity in this professional group.

A number of cross-sectional investigations (e.g. De Moor et al., 2006; Vallance et al., 2011) have shown that exercisers are generally less anxious and also less depressed than non-exercisers. Although this cross-sectional type of research has consistently demonstrated that low physical activity is associated with increased symptoms of mental disorders, it does not provide answers regarding associations across time and, therefore, offers only weak evidence in terms of cause and effect. Stronger evidence, however, exists from longitudinal studies that tested whether baseline physical activity prospectively predicts psychological functioning at follow-up (e.g. Jonsdottir et al., 2010; Strawbridge et al., 2002; Wang et al., 2011). Many of these studies have found that individuals with higher physical activity at baseline generally have a significant reduced risk of depression at follow-up, or reduced risk of developing

depression during the follow-up period, than people with low level of activity. These studies have provided additional support for the link between physical activity and depression because they demonstrated that the associations exist also across time, or at least over two time-points.

Although prospective studies provide substantial evidence that baseline levels of physical activity predict future development of symptoms of mental disorders, they do not target associations of change between physical activity and depressive symptoms.. To be able to thoroughly address such associations of change, strong longitudinal designs with multiple measurement times and appropriate analytical models are needed. Latent growth curve models (LGCM; McArdle, 2009; Meredith & Tisak, 1990; Willett & Sayer, 1994) are highly suitable for this purpose, because they not only describe any single individual's developmental trajectories across time, but also take into consideration interindividual differences in these intra-individual trajectories. Multivariate LGCM are especially well suited for examining key features in the associations of change between variables from a traditional between-person perspective. For example, if people make changes in physical activity, relative to others, do they also change, relative to others, in mental health? These models are also suited to examine associations from a within-person perspective. For example if individuals deviate from the expected curve in physical activity at a specific time-point, will they also be higher or lower than expected in mental health at that particular time point? Few researchers have, up to now, used LGCM to analyze the relationships between naturally occurring changes in physical activity and mental disorders.

Lindwall and colleagues (Lindwall, Larsman & Hagger, 2011) recently used a latent difference score model, which is a subtype of LGCM, to examine how latent changes in physical activity across two measurement times 2.5 years apart were associated with latent changes in depression in 17,593 older adults from 11 European countries. The results showed that latent changes in physical activity were related to latent changes in depression and that

these change correlations were stronger among older adults than younger adults. This study, however, only used data from two measurement times and provided a limited picture of the potential complex interplay between changes in physical activity and mental health, making the use of LGCM impossible.

To the best of our knowledge, only two studies have used LGCM to examine associations of change in physical activity and mental health. Motl, Birnbaum, Kubik, and Dishman (2004) conducted a study that included 4,594 adolescent girls who were assessed three times over a 1.5-year period. The authors found that a 1 *SD* unit increase in the frequency of leisure-time physical activity was accompanied by a 0.25 *SD* unit decrease in depressive symptoms (or an inverse correlation of -.27 between change in physical activity and change in depression) even after controlling for, socioeconomic status, and other potentially confounding factors. This study, however, included a relatively short follow-up (1.5 years) in adolescents and only examined between-person associations of change (slope-slope correlations) and not associations of within-person change (fluctuations). Recently Ku, Fox, Chen, and Chou (2012) analyzed the longitudinal relationship between physical activity and depression in 1160 older (aged ≥67 at baseline) participants from Taiwan across four measurement occasions over 11 years. They found that rate of change (i.e., increase) in physical activity was negatively and significantly ($\beta = -.22$) associated with rate of change (decrease) in depressive symptoms. This study, however, targeted only older individuals. Moreover, only between-person, and not within-person, change associations were examined.

To summarize, although longitudinal prospective studies that have examined physical activity and mental health across time do exist, the majority of these studies have typically looked at predictions across time (e.g., exploring whether baseline physical activity predicts future mental health, rather than analyzing change and associations of change). The highly relevant question of how change in physical activity is related to change in mental health has not been properly answered by previous research, leaving a substantial gap in the

understanding of how changes, and not only regarding levels of physical activity, follow or travel across time with changes in mental health.

The conceptual aim of the present study was to advance the knowledge base when it comes to understanding how physical activity and mental health may display complex and dynamic patterns of change associations across several measurement occasions across several years. More specifically, the purpose of the present study was to examine whether intra-individual changes in physical activity are correlated with intra-individual changes in mental health across four measurement time-points over 6 years, both from between-person and within-person perspectives. To be able to answers these questions, relationships between: (a) starting levels (intercepts); (b) change (slopes); (c) and occasion-specific fluctuations (residuals) in physical activity, depression, anxiety, and burnout will be examined. The hypotheses of the study were:

1. Starting levels of physical activity will be associated with starting levels of all three mental health variables measured.
2. Change in physical activity will be associated with change in all three mental health variables on a between-person level (correlated change).
3. Occasion-specific fluctuations in physical activity will be associated with occasion-specific fluctuations in all three mental health variables (coupled change).

Method

Participants and Procedure

This study is part of a larger survey that has the general aim of examining the interplay between psychosocial stress and stress-related health problems among employees in the public service sector. We have previously examined the relationships between physical activity and mental health in the same cohort, using only two waves of data where cross-sectional relationships and predictions across time were targeted, but not associations of change (Jonsdottir et al., 2010). Baseline data was assessed by means of a postal

questionnaire in the spring of 2004 (T1) with three follow-ups in 2006 (T2), 2008 (T3) and 2010 (T4). The original sample consisted of a random selection of 6000 persons, mainly health care workers (5,300 out of 48,600 employees) and workers at social insurance offices (700 out of 2,200 employees) from the region of Västra Götaland, Sweden. Criteria for inclusion were: at least one full year of employment and working at least halftime. The social insurance offices did not participate in the last follow-up, and this subpopulation not included in the present study. Participants received detailed information about the purpose of the study and the voluntary basis of their participation. All participants were assured of the confidentiality of their responses, and they gave informed consent. Participants were requested to complete several scales related to occupational burnout, perceived stress, symptoms of mental disorders, and level of physical activity (detailed below). The study was approved by the regional ethical review board in Gothenburg, Sweden and conducted according to the principles of the Declaration of Helsinki.

After two reminders, the baseline response rate at T1 was 61% among the health care employees, which corresponds to a total baseline sample of 3,717 participants, 3197 (86%) women and 520 (14%) men. The mean age of the participants was 46.9 years (SD =10.0) and 79% reported being married or living with someone. The majority of participants (81%) perceived their health to be quite good or very good. Participation rate was lower among men compared to women (the ratio men/women deviated 1.7% from that in the original sample). Participants worked in hospitals, primary care, dental care, or health care administration. The largest professional groups were nurses (n = 1,003; 27%), nursing assistants (n = 595; 16%), medical secretaries (n = 223; 6%), dental nurses/hygienists (n = 186; 5%), and physicians (n = 149; 4%). Response rates at follow-ups of those eligible (still employed and being able to receive the questionnaire by mail) was 84% at T2 (n = 3,136), 53% at T3 (n = 1,982), and 40% at T4 (n = 1,497).

Measures

Physical activity. Physical activity was assessed with an adapted version of the widely used one-item, 4-level Saltin Grimby Physical Activity Level Scale (SGPALS; Saltin & Grimby, 1968; Rödjer et al., 2012). This scale makes a distinction between participants: who are mostly sedentary (level 1), who engage in light physical activity (e.g. gardening, walking, bicycling to work) for at least two hours a week (level 2), who report at least two hours per week of moderate physical activity (e.g. aerobics, dancing, swimming, playing soccer, heavy gardening; level 3), or who engage in vigorous activity at least five hours per week on several occasions (level 4). Participants reported their levels of physical activity for the last 3 months. Previous investigations have shown that this simple instrument successfully discriminates sedentary and active individuals regarding their maximal oxygen uptake (Saltin, 1977). Moreover, this one-item instrument has been successfully used in large-scale epidemiologic studies to substantiate that high levels of physical activity are associated with lower risks for morbidity and premature death (Byberg et al., 2009; Jonsdottir et al., 2010).

Although this measure does not provide information about different types of physical activity, it can be argued that the lowest level also includes sedentary behavior, with no leisure-time physical activity or exercise participation. The second level describes individuals who engage in some form of leisure-time physical activity, and the last two levels include individuals who are involved in some form of intense physical activity, exercise, or sport participation.

Burnout. Burnout symptoms were measured by using the Shirom-Melamed Burnout Questionnaire (SMBQ). Depending on the theoretical basis used for the term burn-out available self-report instruments differ (Shirom & Melamed, 2006). The burnout construct measured in this study is based on the definition Melamed and colleagues provided: burnout is a construct related to the feeling of physical, emotional, and cognitive exhaustion resulting from a chronic exposure to stress (Melamed, Kushnir, & Shirom, 1992). The SMBQ contains 22 items with response options anchored on a 7-point Likert scale varying from 1 *(almost*

never) to 7 *(almost always)*. Mean scores ranging between 1 to 7 were calculated to generate an overall index. The SMBQ has proved, in prior research, to be an instrument trough which valid and reliable data on burnout can be collected (Melamed et al., 1999). In the present sample, the Cronbach's alpha values of the SMBQ ranged between .82 and .83 at the four measurements periods.

Anxiety and depression: The Hospital Anxiety and Depression scale (HADS) was used to measure the participants' self-reported symptoms of depression and anxiety. The HADS is a widely used instrument that was originally designed to enable non-psychiatric clinics to detect states of depression and anxiety (Zigmond & Snaith, 1983). The HADS consists of 14 items, seven each for the depression and anxiety subscales. Mean subscale scores were calculated to obtain two overall indices for depression and anxiety. For descriptive purposes, we used the cut-off sum score of 8 and above for each of the two subscales to classify possible cases of depression and anxiety (Bjelland, Dahl, Haug, & Neckelmann, 2002). The HADS has, in previous investigations, shown to be a sound instrument for collecting valid and reliable data on depression and anxiety (Bjelland et al., 2002; Brennan, Worrall-Davies, McMillan, Gilbody, & House, 2010). The internal consistency was good in the present sample, with Cronbach's alpha values ranging between .86 and .87 for depression and anxiety subscales from T1 to T4.

Analyses

The main analyses were based on the full sample (N = 3,717) at baseline. To handle missing data, full information maximum likelihood (FIML) was used in these analyses. In the multivariate analyses, however, we also analyzed data using only participants who completed at least three measurements (n = 2,233) and participants who completed all four measurements (n = 1,497). Chi-squared tests and t tests were used to compare completers with non-completers at baseline. Latent growth curve models (LGCM), which are a specific case of mixed- or random-effects models, were used to analyze patterns of true change and

associations of true change between physical activity and mental health (Duncan, Duncan, & Stryker, 2006). In LGCM within the structural equation modeling framework, observed repeated measures across time are used as indicators of unobserved (latent) underlying true growth trajectory factors. Hence, LGCM include a powerful and flexible methodology with which to model intra-individual changes, interindividual differences in intra-individual change and how level and true change are related. In the present study, multivariate LGCM were used to estimate the co-variation of individual differences in physical activity and mental health variables in: (a) initial status at baseline, (b) linear rate of change, and (c) systematic occasion-specific deviations (within-person correlations).

In the present study, LGCM were fit to data using Mplus (version 5.21, Muthen & Muthen, 1998-2009) with a robust maximum likelihood estimator (MLR). The baseline univariate model contained: (a) a latent factor of mean level (i.e., sample average initial value of physical activity at baseline), (b) a latent factor of mean change (i.e., sample average change trajectories in physical activity across the four measurement points), (c) a latent factor of variance of level (i.e., interindividual differences in physical activity at baseline), and (d) a latent factor of variance in rate of change (i.e., interindividual differences in physical activity change). To examine possible nonlinear (quadratic) effects, a quadratic slope factor was included in additional models using squared time-scores (i.e., 0, 4, 16 and 36 instead of 0, 2, 4 and 6 for the linear slope factor) to represent a non-linear function. Moreover, the covariance between level and change was also modeled. One univariate LGCM was run for each of the four main variables (physical activity, depression, anxiety, and burnout). In the multivariate LGCM, we examined covariation between: (a) intercepts (correlation at baseline), (b) slopes (correlated change), and (c) occasion-specific residuals (coupled change). The slope-slope correlations and the correlated change may be interpreted as the extent to which within-person trajectories of physical activity and mental health are related between persons across the four measurement points. The correlation between occasion-specific residuals, on the other hand,

reflects within-person correlations and answers the question: are state-like fluctuations at each measurement time in physical activity associated with similar fluctuations at each time in mental health variables? The following fit indices were used: (a) chi-square statistics, (b) Bentler´s comparative fit index (CFI), and (c) the root mean square error of approximation (RMSEA). The CFI is a normed incremental fit index (ranging from zero to 1.00, with higher values indicating better fit) that measures the proportionate improvement in fit by comparing a target model with a more restricted baseline model (Hu & Bentler, 1999). In contrast, the RMSEA is an absolute fit index that does not rely on comparison with a reference model but measures the absolute misfit of a model, with lower values indicating better fit (Hu & Bentler, 1999). For CFI, values close to .95 or greater indicate a well-fitting model, whereas values of .06 and less for the RMSEA indicate a good model-data fit (Hu & Bentler, 1999)

Results

Participant Characteristics and Drop-out Analyses

Descriptive statistics of the outcomes variables are described in Table 1. Most participants reported being physically active, at least with light intensity, at baseline with 563 participants (15.3%) who were physically inactive (level 1), 1,658 (53.0%) who reported light physical activity, 1,075 (29.1%) who engaged in moderate, and 98 (2.7%) who were involved in vigorous physical activity. Moreover, the majority of the participants demonstrated normal, or non-clinical (i.e., HADS scores < 8) levels of depression (M = 3.54, SD = 3.26) and anxiety (M = 5.61, SD = 4.01) at baseline. Similarly, most participants displayed levels of burnout (M = 3.07, SD = 1.26) lower than the cut-off value (SMBQ scores < 3.75) indicating high burnout levels. At baseline, participants who reported working part-time were less physically active and scored higher on the burnout scale (p < .05) compared with participants working full-time.

Comparing participants who completed all four waves and dropouts, the dropouts had higher scores on all three mental health variables at baseline: depression, t (3,640) = 3.44, p < .001; anxiety, t (3,618) = 2.88, p < .001; and burnout, t (3,437) = 3.77, p < .001. Reflecting the differences in mean scores of HADS and SMBQ, a larger proportion of the dropouts were also classified as being possible cases of depression and anxiety (i.e., HADS scores ≥8) and high burnout (SMBQ score ≥ 3.75) compared with completers. Moreover, dropouts were less physically active, t (3,689) = - 2.98, p <.001, and older, t (3,715) = 6.00, p <.001, at baseline. Finally, there were more men, χ^2 (1, N = 3717) = 8.82, p <.01, and more individuals not being married or living with someone, χ^2 (1, N = 3717) = 7.40, p <.01 among the dropouts.

Patterns of Change and Between-Person Differences in Change in Physical Activity and Mental Health

Based on the full baseline sample, the univariate linear LGCM fitted the data well, for physical activity: χ^2 (5, N = 3717) = 22.63, p <.001, CFI = .99; RMSEA = .031 (95% CI =.019-.044); for depression: χ^2 (5, N = 3717) = 25.74, p < .001, CFI = .99; RMSEA = .033 (95% CI = .021-.047); for anxiety: χ^2 (*5, N* = 3717) = 27.52, p < .001 , CFI = .99; RMSEA = .035 (95% CI = .023-.048); and for burnout: χ^2 (5, N = 3717) = 44.76, p < .001, CFI = .99; RMSEA = .046 (95% CI = .034-.059). The parameters from these models, described in Table 2, demonstrated a significant mean change (slope) for physical activity, depression, anxiety, and burnout. On average, individuals became significantly more active, less depressed, less anxious, and experienced less burnout over the four measurements. For depression, anxiety, and burnout, but not for physical activity, there was also support for a non-linear function, reflected by significant (ps < .05) quadratic terms in the models (see Table 2). More specifically, when adding a quadratic term in these models, the slopes were still negative but the quadratic terms were positive, demonstrating a decelerating decrease, that is, a decrease that levels out in depression, anxiety, and burnout across time. The variances for both

intercepts and slopes were significant for physical activity and all three mental health variables, indicating significant heterogeneity in the sample and variations between persons in levels at baseline as well as in change. Finally, the significant and negative correlations between intercept and slopes for all four variables (r = -.19 to -.35, ps <.05) reflect a pattern that higher baseline values were related to steeper declines for the mental health variables and to lower increases for physical activity.

Associations of Change in Physical Activity and Mental Health

The multivariate unconditional LGCM[1], which links change parameters in physical activity with change parameters in depression, anxiety and burnout, also fitted data well: for the physical activity-depression model: $\chi^2(22, N = 3717) = 112.54$, p <.001, CFI=.99; RMSEA: .033 (.027-.039); for the physical activity-anxiety model $\chi^2(22, N = 3717) = 88.48$, p <.001, CFI=.99; RMSEA: .029 (.022-.035), and finally, for the physical activity-burnout model: $\chi^2(22, N = 3717) = 180.86$, p <.001, CFI=.98; RMSEA: .044 (.038-.050). As demonstrated in Table 3, there were significant correlations between the intercepts (values at baseline) of physical activity and depression (r = -.37, p <.01), physical activity and anxiety (r = -.27, p <.01) and physical activity and burnout (r = -.40, p <.01), supporting the first hypothesis of the study. These moderate and negative correlations indicate that more physical activity is associated with fewer symptoms of depression, anxiety, and burnout at a cross sectional level at baseline. Moreover, there were also moderately strong and negative between-person correlations (correlated change) of intra-individual change (slope) in physical activity and change in depression (r = -.66, p <.01), anxiety (r = -.57, p <.01) and burnout (r = -.79, p <.01), providing support for the second hypothesis of the study. These results show

[1] Linear models were used for the multivariate LGCM, despite the fact that support was found for a non-linear function for depression and burnout. The reason for this was twofold. First, interpretation of the slope-slope association is problematic when adding a quadratic term, as the linear and quadratic terms are confounded. Secondly, the model fit of the linear growth models for depression and burnout was still very good, indicating that these models are tenable to use.

that individuals who became more active compared to others across the six years also showed a larger decrease in symptoms of depression, anxiety, and burnout. Conversely, individuals who displayed less increase in physical activity than others also displayed less decrease in symptoms of depression, anxiety and burnout. The slope-slope correlations are illustrated in Figure 1. Finally, the correlations between the within-person occasion-specific deviations (residuals) of physical activity and mental health were weak but significant, ranging from -.08 to -.14 (*p*s <.01), providing some support for the third hypothesis of the study. These lower-bound within-person correlations (or coupled effects) indicate that when individuals were more physically active than expected at a specific occasion, they also showed less mental health symptoms than expected.

When using only participants that completed three waves of data, or all four waves of data, in the multivariate LGCM, the estimates of associations between intercepts and residuals were basically the same as when analyses were based on the full sample (Table 3). The associations between slopes of physical activity and mental health variables in these more conservative analyses, however, were weaker, albeit still moderately strong, ranging from -.49 to -.58 (*p*s <.01).

Adding age and gender as covariates of intercepts and slopes in the models only had small influences on the correlations. For example, the slope-slope correlations became somewhat stronger (e.g., r = -.61, compared with r = -.57, for physical activity and anxiety; r = -.70 compared with r = -.66 for physical activity and depression) when controlling for age and gender, compared with the correlations in the unconditional models.

Discussion

The purpose of the present study was to examine the dynamic associations of naturally occurring changes in physical activity and symptoms of mental health, measured as depression, anxiety, and burnout, across four measurement occasions and over six years. In general, robust support for associations between starting levels, correlated (between-person) change, as well as coupled (within-person) change regarding physical activity and mental health, was found for all these three mental health variables. In other words, positive changes in physical activity were associated with positive changes in depression, anxiety, and burnout across time. At the between-person level of analysis individuals who demonstrated stronger increases in their activity levels compared with others also displayed stronger decreases in symptoms of depression, anxiety, and burnout. At the within-person level, occasion-specific fluctuations in physical activity were associated with similar fluctuations in mental health. At occasions when individuals were more active than expected from their expected curve, they also tended to report fewer symptoms of depression, anxiety, and burnout than expected. These findings add important information to the existing body of knowledge relating to physical activity and mental health in non-clinical adult populations.

The suggestion that higher physical activity is related to, in particular, lower symptoms of depression, but also lower anxiety levels, is well documented in previous cross-sectional studies (e.g., De Moor et al., 2006; Vallance et al., 2011). The negative correlations between intercepts of physical activity and mental health in the present study are in line with previous cross-sectional studies. In addition, there are a number of large prospective studies that have demonstrated that higher levels of physical activity at baseline predict lower risks of depression in the future (e.g. Jonsdottir et al., 2010; Lindwall et al., 2011; Strawbridge et al., 2002), which supports the suggestion that these relationships also hold across time. Most of these previous studies, however, have targeted predictions across two time points rather than

the concept of *on-going* change and associations of change. They have offered quite stationary, and thereby limited, snap-shot pictures of how physical activity and mental health move together across time.

To the best of our knowledge only two previous studies (Ku et al., 2012; Motl et al., 2004) have used a similar longitudinal design and analytical approach (i.e., LGCM) as was used in the present study, studying associations of change in physical activity and change in mental health. These studies also found a negative relationship between changes in physical activity and mental health, measured as symptoms of depression, although these associations were weaker than in the present study. This difference in the strength of associations of naturally occurring changes in physical activity and depression may be due to a number of factors. Although these studies were quite similar to the present one regarding measurement, all three studies used single item measures of physical activity and validated scales of depression (CES-D vs. HADS), they differed with regards to other aspects such as characteristics of the sample (e.g., age, gender, cultural background) and design. For example, compared to the present study, the Motl research had a shorter follow-up period (2 vs. our 6 years) and targeted only adolescents. Ku and colleagues examined older Taiwan adults and found an overall increase in depressive symptoms and a decrease in physical activity over time, whereas the opposite pattern was found in the present study on middle-aged Swedish working adults. All these differences between all the studies may have contributed to the different strengths of associations of change.

The associations of physical activity and burnout, and in particular the association of change between these factors, have not been addressed by previous work and deserve special attention. High burnout has been related to poor physical health, and several physiological mechanisms underlying this relationship, linked to allostatic load, have been suggested such as metabolic processes, micro-inflammation, or a deregulation of the HPA-axis (Melamed et al., 2006). Physical activity has been associated with several key components of allostatic

load and has been suggested as a potentially potent tool for managing chronic stress and allostatic load (McEwen, 2007). The results of the present study, showing that burnout and physical activity change together across time, both from a between-person and within-person perspective, are in line with this suggestion and provide further evidence for the potential role of physical activity in the prevention and treatment of stress-related syndromes, such as burnout. Moreover, a recent study (Toker & Biron, 2012) showed that physical activity attenuated relationships of change across time in depression and job burnout, such that relationships of change in depression and burnout was strongest among inactive employees and non-significant among those engaging in high physical activity. Such results provide further insights into the complex and dynamic associations between physical activity and mental health over time.

To our best knowledge, the within-person changes between physical activity and mental health have not been addressed in any previous study. Although significant, the estimates were considerably weaker than the between-person correlated change estimates. This trend has also been found in other areas, such as cognitive aging, regarding associations of between-person and within-person change in different domains of cognition (Sliwinski, Hofer, & Hall, 2003), and could be attributed to a number of factors. In general, these within-person coupled associations will be attenuated because the residuals are comprised of both systematic and random sources of variance. For this reason, these estimates will be *lower bound* estimates of time-specific association. For example, poor measurement precision with few indicators of each construct and suboptimal study design with few measurement occasions that are insensitive to picking up true within-person change in different variables may weaken within-person correlations. Linked to this issue, in the present study, physical activity was measured with only one item, leaving less room for within-person variation across occasions. Moreover, the design of four measurement occasions, each separated by two years, may be less than optimal for finding associations of within person changes in variables

such as physical activity and mental health. It is important to highlight that finding associations of between-person changes does not necessarily mean that one will also find similar associations at the within-person level. Rather than being redundant, these two levels of analysis provide complementary information (Sliwinski & Buschke, 2004) that together may increase our understanding of whether two variables, such as physical activity and mental health, do change together, and when and under what circumstances they change together and why.

Some of the estimates, primarily the slope-slope associations, were weaker in the analyses that included only participants who had three or four waves of data compared with the analyses including all participants. The issue of differences between dropouts of the study versus completers may therefore be relevant to discuss and understand in our study, as for most prospective studies. For example, the participants (n = 1,497) who completed all four waves were more physically active as well as less depressed, anxious, and burned out at baseline compared with dropouts who did not complete all four waves, providing a general *healthy-worker* pattern that is frequently found in similar prospective studies. Moreover, being employed at each wave was an inclusion criterion of the study, which means that the main findings may primarily be generalized to a healthy working population that maintains employment across time. It is not clear, however, if these results may be generalized to groups of individuals who, voluntarily or not, lose their jobs due to a number of different reasons (e.g., health issues).

Given the observational nature of the longitudinal design in the present study, no conclusions in terms of cause, or effect or directions of effects, can be drawn. Therefore, the suggestion that changes in mental health lead to changes in physical activity is equally valid to the proposition that changes in physical activity lead to changes in mental health, or that both directions exists, resulting in a dynamic reciprocal relationship across time. Supporting this latter hypothesis, previous studies have demonstrated that the longitudinal relationship

between physical activity and depression may be best described as reciprocal (Lindwall et al., 2011). The use of a single-item self-report measure of physical activity should also be highlighted as a limitation of the study. Although there is support from several studies (Byberg et al., 2009; Jonsdottir et al., 2010; Rödjer et al., 2012) that the use of this measure may result in valid conclusions in regards to levels of physical activity, it should be noted that the measure is quite broad and includes a mixture of purposeful activity and transportation. The use of objective measures of physical activity (e.g., pedometers) might have resulted in a different pattern of associations. Moreover, because the sample consisted of Swedish health care workers, primarily female, middle-aged, and well-educated, and few previous studies using the same analytical approach exist, it is uncertain how well the results may generalize to different populations. Strengths of the study include the longitudinal design with four measurement points across 6 years and the relatively large sample of middle-aged adults. Also, the use of advanced analytical models of LGCM offered a number of relevant benefits, such as control for measurement error, modeling of true change trajectories and complex change associations on both between- and within-person levels.

Additional aspects could be raised when studying natural courses of changes in health-related factors over time in a large working population. Many different organizational-related changes and initiations of different projects or changes in the community are bound to happen during the period, and surveys can only record changes in the population without interfering or being able to control for all on-going changes that will occur. For example, during the follow-up period of the study, a large healthy lifestyle-promotion project was initiated and led by the human resources department of the employers (see Jonsdottir, Börjesson, & Ahlborg, 2011). Because one of the four themes of the project was physical activity, the potential influence of this project on the changes in activity levels in the same working population included in this study is worthy of mentioning. An indirect effect could be that more people did become active during the period, contributing to the general trend in the sample of

increasing physical activity. Nevertheless, as relatively few participated (21% of the study population in this present study), and most of those who did were already active (Jonsdottir et al., 2011), the influence of the project on the demonstrated relationships of change in the present study is most probably of minor relevance.

From the clinical perspective, the results of the present study support the notion that professionals, working with physical activity as a preventive tool against mental disorders, should be aware that change in physical activity (and not only the current or previous status of physical activity) may be associated with future mental health trajectories. There is strong rationale to continue working for improved activity levels in less active adults. In addition, our results supports the efforts to maintain the physical activity level in already active individuals to avoid decreases in activity that seems to be accompanied with increased risks for developing symptoms of depression, anxiety, and burnout. As this study did not include patients with mental disorders, the treatment effect of increased physical activity levels was not studied. Meta-analyses (e.g., Josefsson, Lindwall, & Archer, 2013), however, have demonstrated that exercise interventions have a significant large overall effect on depressive symptoms among clinically diagnosed depressed adults. In line with this evidence, exercise may be recommended, not only as a preventive measure for healthy individuals, but also as a treatment for people with mild to moderate depression who are willing, motivated, and healthy enough to engage in such program.

Establishing relationships at a cross-sectional level is the first important step, followed by the examination of whether physical activity also predicts future mental health. To further improve our understanding, however, researchers should now move beyond the traditional prospective two-occasion *predictions-across time* analyses to the next level and start to examine more complex associations of change across more than two occasions. Finding consistent associations on this change-change level also would substantially strengthen the

scientific support for the role of physical activity in the prevention of mental disorders for non-clinical groups of adults.

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Table 1

Descriptive Statistics Across All Four Time Points (T1-T4) for the Full Sample (N =3717)

	T1		T2		T3		T4	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Physical activity	2.19	0.72	2.19	0.70	2.25	0.71	2.26	0.74
Depression	3.54	3.26	3.22	3.14	3.04	3.00	2.95	3.09
possible cases[a] ,%	12.8		10.9		9.1		10.5	
Anxiety	5.61	4.01	5.19	3.91	4.97	3.87	4.76	3.87
possible cases[a], %	28.9		25.7		23.2		21.8	
Burnout	3.07	1.26	2.95	1.23	2.85	1.19	2.86	1.22
high burnout[b] , %	29.0		25.8		22.0		22.9	

Note: [a] HAD scores ≥8; [b] SMBQ score ≥ 3.75

Table 2

Means and Variances for Parameters (Intercept and Slope) in the Univariate Linear Latent Growth Curve Models for Physical Activity, Depression, Anxiety, and Burnout

Variable	Intercept Mean (SE)	Slope Mean (SE)	Quadratic Mean (SE)	Intercept Variance (SE)	Slope Variance (SE)	Quadratic Variance (SE)	Intercept-Slope correlations
Physical activity	2.19 (0.01)*	0.008 (0.003)*	ns	0.27 (0.01)*	0.002 (0.001)*	ns	-.18*
Depression	3.54 (0.05)*	-0.20 (0.03)*	0.02 (0.005)*	7.56 (0.57)*	0.44 (0.17)*	0.01 (0.003)*	-.35*
Anxiety	5.61 (0.07)*	-0.19 (0.04)*	0.01 (0.006)*	12.13 (0.82)*	0.85 (0.24)*	0.02 (0.004)*	-.19*
Burnout	3.07 (0.02)*	-0.07 (0.01)*	0.01 (0.002)*	1.32 (0.08)*	0.10 (0.02)*	0.002 (0.000)*	-.23*

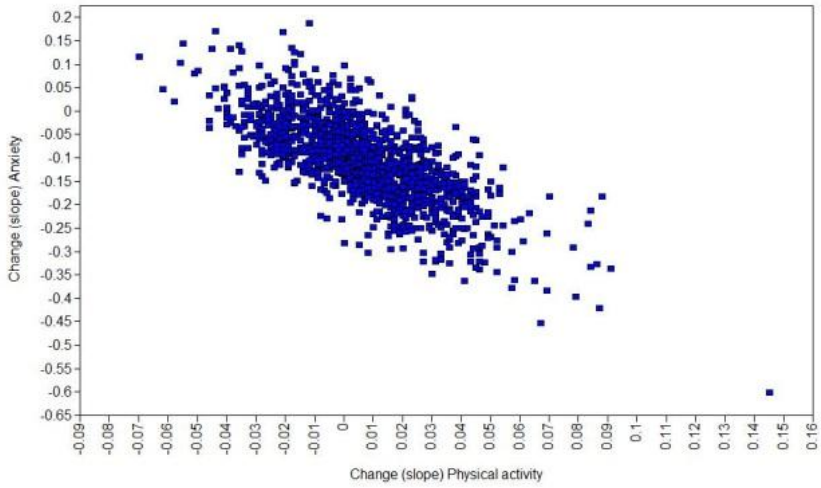
Note: *p <. 05; ns = non-significant

Table 3

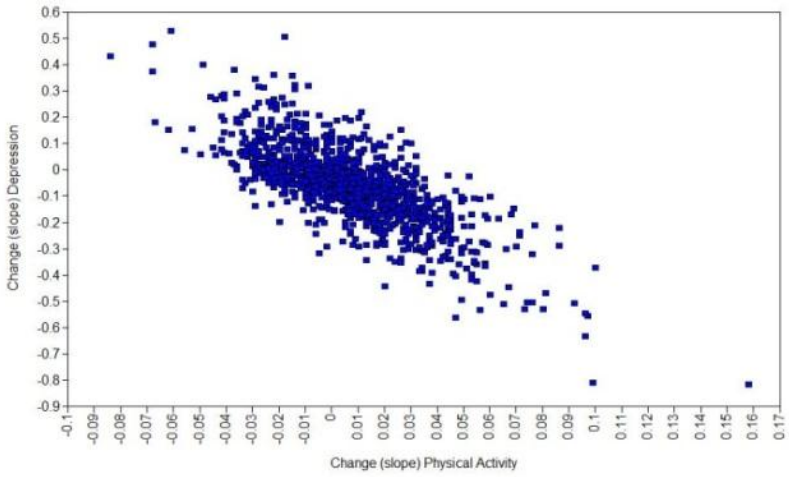
Standardized Correlations Between Level (Intercept), Change (Slope) and Occasion-Specific Fluctuations (Residuals) in Physical Activity and Mental Health (Depression, Anxiety and Burnout)

		Physical activity	
Variables	Intercept	Slope (correlated change)	Residuals (coupled change)
Intercept			
Depression	-.37*-.35*/-.35*		
Anxiety	-.27*/-.29*/-.28*		
Burnout	-.40*/-.39*/-.40*		
Slope			
Depression		-.66*/-.61*/-.52*	
Anxiety		-.57*/-.57*/-.49*	
Burnout		-.79*/-.72*/-.58*	
Residuals			
Depression			-.12*/-.12*/-.10*
Anxiety			-.08*/-.09*/-.08*
Residuals			-.16*/-.16*/ -.14*

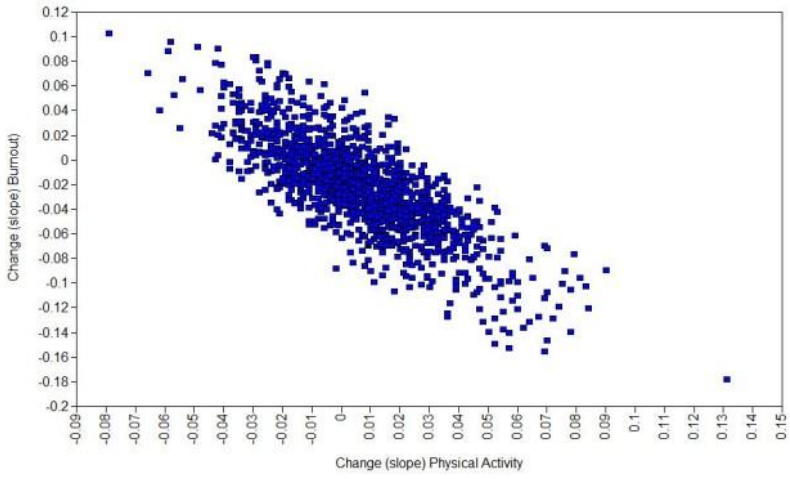
Note: The first, second, and third estimates in each cell refer to correlations in the analyses including all (N = 3,717) participants (first estimate), participants (n = 2,233) who completed three waves of data (second estimate), and participants (n = 1,497) who completed all four waves (third estimate), respectively. The estimates reported in the table are from the unconditional models without covariates. Note: *p < .01;


Change (slope) Anxiety
Change (slope) Physical activity

(a)


Change (slope) Depression
Change (slope) Physical Activity

(b)


Change (slope) Burnout
Change (slope) Physical Activity

(c)

Figure Caption

Figure 1. Associations of Change (Slope-Slope Associations) for Physical Activity and (a) Anxiety, (b) Depression, and (c) Burnout.