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PHYSICAL EXERCISE AND ANXIETY AS MODERATORS OF THE STRESS-ILLNESS RELATIONSHIP

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This study examines the interplay of unemployment stress, trait anxiety and physical exercise in the development of physical health. Longitudinal data were taken from a sample of East German migrants ($N = 330$) who were confronted with the potentially stressful demand of finding a job in the Western society. Unemployment stress was found to exert a main effect on illness level. Trait anxiety was a moderator of the stress-illness relationship, but exercise was not. As indicated by a three-way interaction involving exercise, anxiety, and stress, exercise was most beneficial among high-anxious subjects who were not exposed to unemployment stress. Results of this study suggest that exercise may not buffer the deleterious effects of stressful situational conditions (unemployment), but may effectively mitigate the health-damaging consequences of lacking personal resources, such as high dispositional anxiety.

KEY WORDS: Anxiety, exercise, stress, illness, unemployment, migrants

Over the last 20 years, considerable evidence has accumulated suggesting that stressful life events such as migration, relocation, or unemployment are linked to ill health (Cohen & Williamson, 1991; Creed, 1985; Kasl & Cooper, 1987; Snyder & Ford, 1987). Although the stress-illness relation is well established, it is also obvious that not all individuals respond with health problems when exposed to major changes in life. The magnitude of the stress-illness association is often low, with stress typically accounting for rarely more than 10% of the variance in the illness indicators (Leventhal & Tomarken, 1987). As a consequence, in recent years the primary research focus has shifted from main-effect models to more complex moderator models which assume that stressful experiences have a deleterious impact on health only under specific personal or situational conditions. Several moderators have been suggested, in particular coping style (Frese, 1986), health practices (Wiebe & McCallum, 1986), social support (Cohen & Wills, 1985; Schwarzer & Leppin, 1991), optimism (Scheier & Carver, 1987), or hardiness (Kobasa, Maddi, & Puccetti, 1982). This paper focuses on two further variables that were hypothesized to exert moderating effects: physical exercise and trait anxiety.

Evidence for the moderator function of *physical exercise* comes from different sources. Laboratory studies suggest a stress-buffering role of exercise because it may contribute to a decreased physiological reactivity to, and a faster recovery from, discrete experimental stressors (Light, Obrist, James, & Strogatz, 1987;

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Perkins, Dubbert, Martin, Faulstich, & Harris, 1986; Sinyor, Golden, Steinert, & Seraganian, 1986). But there is also evidence that exercise may cushion the deleterious impact of naturally occurring stressful events on physical health (Brown, 1991; Brown & Lawton, 1986; Kobasa et al., 1982). However, literature inquiries revealed only one single study that successfully identified the stress-buffering role of exercise[1] within a longitudinal design (Brown & Siegel, 1988). In this study, highly stressed girls (grades 7–11) who were physically active reported fewer health problems than their highly stressed peers with a lower activity level. Several other investigations did not find moderating effects of exercise (Brown, 1991 [prospective analyses]; Kobasa, 1982; Roth & Holmes, 1987; Roth, Wiebe, Fillingim, & Shay, 1989), suggesting that further research is warranted before any definite conclusions on the stress-buffering effect of exercise can be drawn. In particular, it is necessary to test this effect with more objective measures not only for health and exercise (Brown, 1991), but also for stress events.

Another proposed stress-illness moderator is *trait anxiety*. Interactional and transactional stress theories (Endler, 1988; Hobfoll, 1989; Lazarus & Folkman, 1984) consider trait anxiety a personal vulnerability factor that has the capacity to affect the relationship between life events and illness because it increases both the likelihood and the extent of perceiving a life event as stressful and threatening. In particular, Endler's (1988) stress-coping model postulates that perception of threat increases state anxiety which in turn may cause biochemical and physiological reactions detrimental to health if the stressful situation continues over a longer period of time. Debilitating effects of chronic life stress have been found especially for long-term unemployment (John, 1987; Linn, Sandifer, & Stein, 1985), the stressful event that is also the focus of the present study. Little is known about the question how the relationship between unemployment stress and physical health might be influenced by dispositional anxiety.

The present study was conducted to determine the role of exercise and trait anxiety as potential moderators of the stress-illness relationship. Exercise as a stress buffer should have positive health consequences, whereas trait anxiety as a vulnerability factor was hypothesized to show an adverse impact on health. Given these opposite effects, both moderators were expected to interact in a complex way with regard to physical health. For instance, it is possible that high-anxious persons may benefit more from regular exercise than low-anxious ones when exposed to stressful life events (cf. Wilfley & Kunce, 1986). However, it is also plausible that exercise can buffer health-damaging effects of situational stress (unemployment) or personal deficiencies (trait anxiety), but not both at the same time. Considering these alternative hypotheses, we had no specific predictions concerning the nature of the triple-order interaction involving stress, exercise, and anxiety. The present study was conducted with a longitudinal sample of East German migrants who were confronted with the potentially stressful demand to find a job in the Western society.

METHOD

Subjects

Subjects were citizens of the former East Germany who had left their country for

[1] Exercise and physical fitness are different concepts. There are longitudinal studies that have found a stress-buffering effect of physical fitness, but not of exercise (e.g., Brown, 1991).

West Germany (and West Berlin) in the course of the revolutionary events during the second half of 1989 and the first two months of 1990. Of the 1,057 participants at the first wave of measurement, 403 participated again at the second wave eight months later. The high number of dropouts is primarily due to the fact that many participants of the first wave were living in temporary accomodations (such as gyms or exhibition halls). It was very difficult to relocate them after these facilities had closed. The study sample consisted of those 330 persons who had complete longitudinal data on the variables relevant for the subsequent analyses. Of the 330 persons, 144 were females and 186 were males. Their median age was 30 years, with a range from 17 to 67.

Measures

Data were collected by a self-report questionnaire which was administered to the participants at two points in time: in the fall/winter of 1989/90 (Wave 1) and in the summer/fall of 1990 (Wave 2). The following measures were obtained.

Illness. The Giessener Beschwerdebogen (Health Complaints Rating Scale; Brähler & Scheer, 1983) was used to measure illness status. Subjects were asked to report physical complaints they had been experiencing since their move to the West (Wave 1) or at the time being (Wave 2) by rating each item on a 5-point intensity scale. Factor analyses revealed 24 of the total of 55 items to load on four dimensions (cf. Brähler & Scheer, 1983): cardiovascular symptoms, gastric troubles, exhaustion, and rheumatic complaints (pain of the limbs). These four dimensions, each based on six items, were used as illness indicators. A total illness score was calculated by summing up the scores of the four subscales. Reliability and validity of the instrument have been documented elsewhere (Brähler & Scheer, 1983). In the present study, the internal consistency of illness scores was alpha = .93. For the subsequent analyses, illness scores were log transformed because their distribution was strongly skewed to the left ($p < .001$). Lower illness scores thus remained relatively unchanged, whereas higher scores were markedly reduced (Kirk, 1982, p.83). The transformation is appropriate because responses in the lower scale range are likely to be much more precise than those in the upper range.

Anxiety. Participants completed a short version of the trait anxiety subscale of the German adaptation of Spielberger's State-Trait Personality Inventory (STPI; Hodapp, Schwarzer, Schwenkmezger, Laux, & Spielberger, 1988; Schwarzer & Schwarzer, 1983). The trait anxiety score was based on four items which had an internal consistency of alpha = .72.

Exercise. Level of physical exercise was estimated by asking, "Here in the West, how many hours per week do you usually spend on sports activities (without biking)?" Subjects responded on an 8-point time scale. This measure was conceptualized to reflect the weekly involvement in physical exercise. We excluded bicycle riding to avoid an inflation of the variable with an activity that is usually not performed as an exercise, but as transportation (cf. Fuchs et al., 1988).

Stress. All participants had left East Germany after August 1989 and were still in the process of adjusting to the novel and very different society. Among the many challenging and threatening tasks they had to deal with, finding a job was one of the most urgent problems. Given the high number of unemployed persons in the sample (68% at Wave 1), we decided not to use a whole battery of stressful events (as in similar investigations), but to examine the possible health effects of only one single stress-provoking condition, that is unemployment after migration. Thus, stress (in the meaning of stressful event) was assessed with the two categories of

having or not having a job. The present study was therefore based on a more objective and content-specific assessment of life stress than previous studies using retrospective self-report measures such as the Life Experience Survey (LES) by Sarason, Johnson, and Siegel (1978).

RESULTS

Table 1 shows the zero-order correlations among the study variables. Stress (employment status), physical exercise, and trait anxiety were significantly related to illness levels at Wave 1 and Wave 2, with the illness-anxiety correlations being markedly higher than the correlations between illness and exercise or between illness and stress. Moreover, anxiety, but not exercise, was significantly linked to stress. Table 1 also reveals that females were more likely to be unemployed and to have lower levels of exercise, but higher levels of anxiety and illness than males. Age was positively associated with stress and illness at Wave 2. Finally, the autocorrelation between both assessments of illness was $r = .59$ ($p < .01$), indicating only a moderate stability over time for this variable.

Table 1 *Zero-order correlations among study variables*

	Stress	Exercise	Trait anxiety	Sex	Age	Illness at Wave 1
Exercise	−.07	—				
Trait anxiety	.21**	−.18**	—			
Sex	.30**	−.19**	.21**	—		
Age	.12*	−.05	.02	.05	—	
Illness at Wave 1	.17**	−.16**	.56**	.21**	.07	—
Illness at Wave 2	.23**	−.16**	.46**	.19**	.14**	.59**

Notes. Anxiety and exercise are continuous variables (in the subsequent ANCOVA both variables were dichotomized). Sex and stress are coded as dummy variables (sex: 1 = male, 2 = female; stress: 1 = employed, 2 = unemployed).
* $p < .05$; ** $p < .01$

An analysis of covariance (ANCOVA) was performed with stress, trait anxiety, and exercise as independent variables (all measured at Wave 1), and illness as dependent variable (measured at Wave 2). To control for initial level of illness (Wave 1) as well as sex and age, these variables were included as covariates. Both anxiety and exercise were split at the median to conduct a 2(Stress) × 2(Anxiety) × 2(Exercise) ANCOVA. The assumption of parallel regression slopes for the covariates within all cells was not violated[2] (cf. Winer, 1971, p. 764). Furthermore, normality and homogeneity of variances of the dependent variables were met (Bartlett-Box $F[7,41543] = .39$; $p = .90$).

Table 2 summarizes the means and standard deviations for the subgroups as well as the major ANCOVA results. A significant main effect was obtained for stress, with unemployed subjects reporting higher illness scores than employed subjects (adjusted means: 90.8 and 73.0). Although there was no significant main effect of

[2] The pooled sum of all possible factor-covariate interactions for each covariate did not reach significance ($F(7,298)$ always < 1.87 and p always $> .08$).

exercise, illness scores differed in the predicted direction, i.e., physically active persons reported less complaints than inactive persons (78.5 and 85.3). Furthermore, no significant main effect of trait anxiety was found; mean illness scores of low- and high-anxious persons were almost identical (81.3 and 82.6).

Table 2 *Illness level at Wave 2 by stress, exercise, and trait anxiety at Wave 1*

	Stress					
		Low (employed)			High (unemployed)	
	n	*M*[a]	*SD*	*n*	*M*[a]	*SD*
Low exercise	74	78.2 [80.6]	52.6	173	100.2 [89.9]	50.1
High exercise	33	62.4 [65.4]	46.1	50	94.7 [91.6]	48.9
Low anxiety	63	65.7 [79.4]	47.4	92	75.8 [83.1]	47.8
High anxiety	44	84.2 [66.7]	54.5	131	115.2 [98.5]	44.5
SUMMARY OF ANCOVA RESULTS:						
Main effects						
Stress		$F(1,319) = 9.66, p = .002$				
Anxiety		$F(1,319) = .05, p = .821$				
Exercise		$F(1,319) = 1.47, p = .226$				
Two-way interactions						
Stress × Anxiety		$F(1,319) = 6.43, p = .012$				
Stress × Exercise		$F(1,319) = 2.33, p = .128$				
Anxiety × Exercise		$F(1,319) = 3.47, p = .063$				
Three-way interaction		$F(1,319) = 4.75, p = .030$				
Covariates						
Illness at Wave 1		beta = .493, $t = 10.15, p = .000$				
Age		beta = .095, $t = 1.98, p = .049$				
Sex		beta = .029, $t = .61, p = .540$				

Note. [a] Means in parantheses were adjusted for covariates.

The ANCOVA also revealed a significant two-way interaction involving stress and anxiety (Figure 1a). Low-anxious persons had similar levels of illness, regardless of whether they were under unemployment stress or not. In contrast, high-anxious persons who were unemployed had higher illness scores than those who were employed (main effect of stress within high-anxiety: $F(1, 319) = 13.97$; $p < .001$). Thus, stress had an effect on illness only among high-anxious individuals.

Although the Stress × Exercise interaction did not reach statistical significance ($p = .128$), this relation is noteworthy because its pattern of means (Figure 1b) revealed exactly the opposite of the expected stress-buffering effect. Exercising or not exercising made no difference in the stress condition (unemployed). However, when not under stress (employed), those who were physically active reported less illness than their inactive counterparts (main effect of exercise within the non-stress condition: $F[1,319] = 2.91$; $p = .089$).

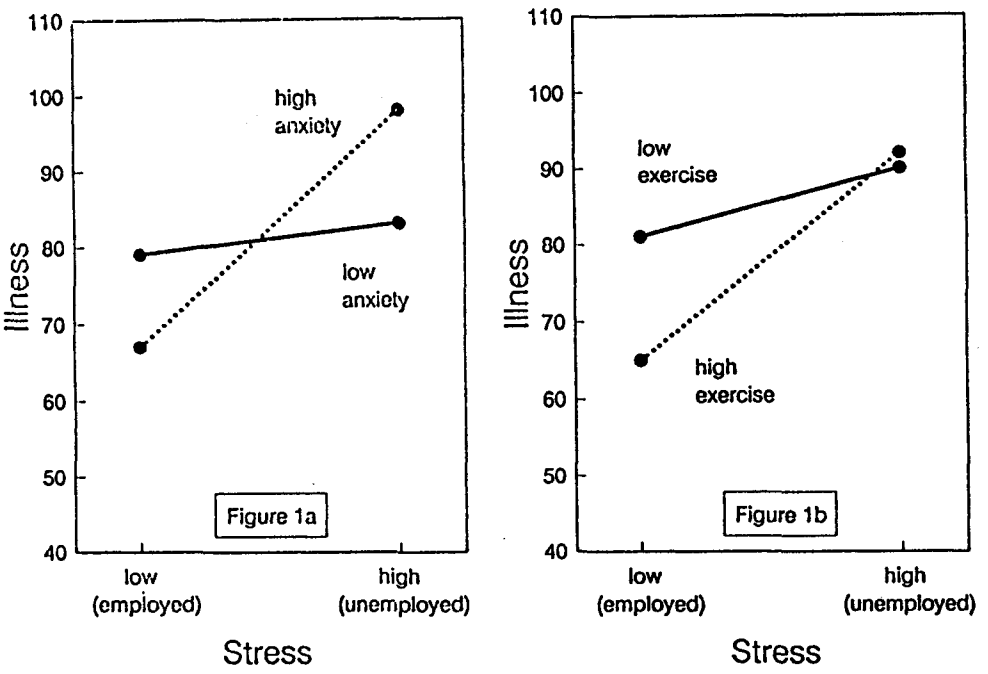

Figure 1a Stress × Anxiety Interaction. Means of illness (adjusted for initial level) by stress and anxiety.

Figure 1b Stress × Exercise Interaction. Means of illness (adjusted for initial level) by stress and exercise.

The Anxiety × Exercise interaction approached statistical significance with $p = .063$. The illness level of low-anxious persons remained unaffected by exercise (adjusted means for low and high exercise: 79.4 and 83.0), whereas the illness level of high-anxious persons was significantly lower among active than among inactive subjects (adjusted means: 74.0 and 91.1; main effect of exercise within high-anxiety: $F[1,319] = 4.13$; $p < .05$). This two-way interaction was further qualified by an Anxiety × Exercise × Stress interaction. Its graphical display (Figure 2) illustrates that exercise had an effect on illness only in one of the four subgroups studied, namely in those with high anxiety levels who were not exposed to unemployment stress (main effect of exercise within high-anxiety and non-stress: $F[1, 319] = 6.99$; $p < .01$).

DISCUSSION

Most studies have used multiple life event measures (e.g., the LES by Sarason et al., 1978) to investigate the effect of physical exercise on the stress-illness association. In the present study, however, it was hypothesized that a single life event (unemployment after migration) would constitute a stressful condition strong enough to have observable health consequences. In fact, a significant main effect of stress on illness level eight months later was obtained, suggesting that unemployed

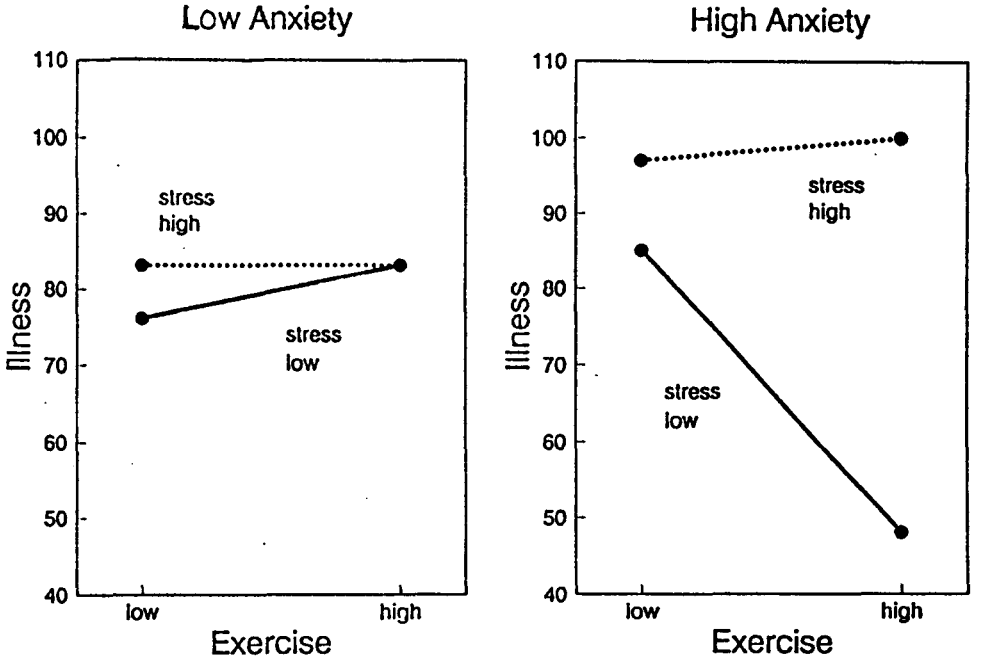

Figure 2 Stress × Anxiety × Exercise Interaction. Means of illness (adjusted for initial level) by stress, anxiety and exercise.

migrants were more likely to develop health problems than employed ones. The zero-order correlation between stress and illness ($r = .23$; $p < .01$) was similar to those found in previous studies (Cohen, 1988; Thoits, 1983). It is possible that the subjects of this study provided an ideal sample to observe the stress-illness relationship because (a) persons who were exposed and not exposed to unemployment stress were more equally distributed than in samples taken from the normal population, and (b) for migrants the state of unemployment may have a more existential meaning than for persons who are well-integrated in a social system; consequently, migrants should be more likely to interprete this life event as actually being stressful.

Contrary to Schwarzer, Jerusalem, and Kleine (1990), who found anxiety at Time 1 to predict health complaints at Time 2, no (longitudinal) main effect of anxiety on illness status was observed in the present study. This discrepancy may be due to the fact that Schwarzer and his colleagues did not control for the initial level of illness as in the present investigation. Our results suggest that dispositional anxiety per se has no importance for physical health. However, the data strongly support the idea that trait anxiety may operate as a moderator of the stress-illness relationship, making people more vulnerable to the health-damaging effects of chronic life stress. High-anxious persons were found to report significantly more health complaints than low-anxious only under conditions of unemployment, but not under conditions of employment (Stress × Anxiety interaction). This result is consistent with the view of the stress process as a reciprocal interaction of person (trait anxiety) and situation (employment status). High trait anxiety increases the likelihood of appraising a demanding situation as threatening (Jerusalem, 1990),

and threat perceptions in turn are related to physiological and biochemical changes that may impede health status (Endler, 1988). The findings are also in accordance with research in the field of neuroimmunology. Locke et al. (1984) found high-anxious persons who experienced high life stress to have the lowest level of natural killer (NK) cell activity, and, hence, a reduced functioning of their immune system. On the other hand, low-anxious persons with high life stress had the highest level of NK-cell activity. Similar results were reported by Dorian and Garfinkel (1987).

Compared, for instance, to the well-documented benefits of exercise for cardiovascular health (Berlin & Colditz, 1990), there is less empirical evidence for the direct impact of exercise on general physical health. On the contrary, main effects of exercise on health indicators such as the Seriousness of Illness Rating Scale (Wyler, Masuda, & Holmes, 1968) were often not significant both in cross-sectional (Brown, 1991; Brown & Lawton, 1986; Roth et al., 1989) and in longitudinal investigations (Brown, 1991; Brown & Siegel, 1988). The present study also failed to identify a significant main effect of exercise on self-reported illness status eight months later. Maybe the subjects of this study and previous ones were too healthy for detecting physical benefits of exercise.

Of particular interest was the question whether we could identify the stress-buffering effect of exercise reported by several researchers (Brown, 1991; Brown & Lawton, 1986; Brown & Siegel, 1988; Kobasa et al., 1982). In the present investigation, the Stress × Exercise interaction did not reach statistical significance, but, more surprisingly, the nature of this relationship was contrary to the expected buffering effect. The graphical inspection suggested that exercise may unfold its health benefits only under stress-free circumstances, but provides no health protection when persons are exposed to unemployment stress. One might speculate that unemployment after migration is such a strong condition that it does not permit exercise to operate as a stress buffer in the same way as for other life events. In this regard, the findings would merely reflect a stressor-specific effect. However, together with the negative evidence from other studies, our results also challenge the stress-buffering hypothesis in general.

Additional results of the present study provided a more detailed picture of the differential effects of exercise. Substantial exercise-health effects emerged only in high-anxious, but not in low-anxious persons (Exercise × Anxiety interaction). More specifically, exercise was most beneficial for high-anxious persons who were not exposed to unemployment stress (Exercise × Anxiety × Stress interaction). These findings support the idea that exercise, though it may not be able to cushion situational stress, could be an effective instrument to mitigate the adverse health effects of personal vulnerabilities such as high trait anxiety. This interpretation is in line with research showing that exercise may reduce psychological tension and state anxiety (Abele, Brehm, & Gall, 1991; Berger & Owen, 1987; McDonald & Hodgdon, 1991; Thayer, 1987), especially in subjects who were more distressed prior to beginning an exercise program (Wilfley & Kunce, 1986). Yet these tension reductions were found to be short-term in nature (Otto, 1984) and need to be maintained by chronic physical activity. The present study suggests that high-anxious persons who have learned to deal successfully with their psychological tension (or state anxiety) by exercising on a regular basis are likely to improve their physical health. However, the data also suggest that tension reduction via exercise may work only if the pressure of situational demands (such as unemployment stress) does not exceed a certain threshold.

Confidence in these conclusions is bolstered by the longitudinal nature of the

data. By controlling for initial level of illness, the analyses examined the effects of stress, exercise, and anxiety on (interindividual) changes in illness status over time. Such prospective results provide stronger evidence for causal inferences than cross-sectional findings. Nonetheless, they have to be interpreted with caution because they only allow to exclude some, but not all possible alternative explanations.

There are several limitations to the present study. If the stress-buffering effect of physical activity occurs primarily as a function of cardiovascular fitness (Brown, 1991), then, in order to detect this effect, the assessment of exercise should focus on aerobic activities which most strongly promote cardiovascular health. Because our measure was designed to assess involvement in any kind of sports activity (except for biking), not only aerobic activities, it is possible that we used an inadequate instrument to identify the stress-buffering effect. However, this caveat is qualified by results from previous studies with more appropriate activity estimates that also failed to prove the stress-buffering effect (Brown, 1991 [prospective analyses]; Roth et al., 1989). Another limitation of the present research concerns the missing information on reliability and validity of the exercise measure. Although there is evidence that single-item estimates of physical activity may have a similar construct validity as more complex measures (Siconolfi, Lasater, Snow, & Carleton, 1985), it is unclear whether this also applies to the estimate used in this study. Finally, external validity of the present findings may be questioned by the high longitudinal attrition. Significant differences between panel subjects and dropouts were found on demographic variables, with dropouts being more frequently males, of younger age, and with lower education. However, both groups did not differ significantly on the major study variables (i.e., stress, exercise, anxiety, and illness), suggesting that the sample bias was still within tolerable limits.

CONCLUSION

Results provided clear evidence that trait anxiety serves as a diathesis in the relation between stress and illness. Although this effect has been suggested by interactional stress theories for many years, the present research is one of the few investigations to prove this effect on the basis of longitudinal data.

Furthermore, the results, together with findings from previous studies, indicate that evidence for the stress-buffering role of exercise is far from being conclusive. The present investigation rather supports the view that exercise may mitigate the adverse health consequences of lacking personal resources (high trait anxiety), but cannot buffer the health-damaging effects of situational stressors (unemployment). The data suggest that the health-protective quality of exercise may be attributable primarily to tension reduction effects induced by regular physical activity in times of low stress, and only to a minor degree to a more efficient physiological reactivity in times of high stress. More research is needed to determine precisely the differential health-effects of exercise under low and high conditions of stress.

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