**SUPPLEMENTAL ONLINE APPENDIX**

**TABLE A1**

**STUDIES EVALUATING PHYSICAL ACTIVITY CORRELATES**

|  |  |  |  |
| --- | --- | --- | --- |
| Authors (Year), Journal | Primary Theoretical Foundation(s) | Sample, Design, Analyses | Main Findings |
| Burtscher et al. (2018), *Journal of Organizational Behavior* | Stress appraisal (Lazarus & Folkman, 1984) | *N* = 45 professional firefighters (Western Europe)  High-fidelity training scenario with objective physical activity assessments and self-report surveys  Multilevel mixed-effects models | Greater physical activity during the simulation was positively associated with perceived strain during the task  The relationship between physical activity and perceived strain is weaker under conditions of high trust in teammates compared with conditions of low trust in teammates |
| Caudroit et al. (2011), *European Journal of Work and Organizational Psychology* | Dualistic model of passion (Vallerand et al., 2003); Self-determination theory (Ryan & Deci, 2000) | *N* = 160 teachers (France)  Cross-sectional survey  Path Analysis | Harmonious passion for work was positively related to leisure time physical activity |
| Evans & Steptoe (2001), *Journal of Occupational Health Psychology* | None | *N* = 93 nurses and accountants  Ambulatory physiological assessment with pre-reading diaries (reflecting on last 15 minutes)  ANOVA | Physical activity was greater for the low work social support group during the daytime but not in the evening |
| Gnam et al. (2019), *International Journal of Stress Management* | Cross-stressor adaptation hypothesis (Sothmann, 2006) | *N* = 48 male firefighters  Quasi-experiment (low vs. high physical activity levels)  *t*-tests / Simple linear regression | More physically active participants reported a higher cognitive stress appraisal leading into a firefighting course final exam than less physically active participants |
| Greenwood, Rich, & James (1995), *Work & Stress* | None | *N*  = 72 rotating-shift shiftworkers  Daily sleep diary (three after night shift, three after day shift)  Factorial ANOVA (night vs. day, day 1, 2, or 3) | Found no relationship between exercising 6 hours nor 4 hours before sleep in relation to sleep duration  Found no relation between exercise duration or proximity of exercise to bedtime and duration of sleep following day shift |
| Hecht & Boies (2009), *Journal of Occupational Health Psychology* | Effort – Recovery Model (Meijman & Mulder, 1998) | *N* = 239 university staff and faculty members (Canada)  Longitudinal study (2 waves)  Multiple regression | Whether one participates in sports, recreation, and fitness non-work activities is negatively associated with somatic complaints and positively associated with life satisfaction  Whether one participates in sports, recreation, and fitness activities is positively associated with positive emotional non-work to work spillover |
| Johnson & Allen (2013), *Journal of Applied Psychology* | Resource drain theory (Edwards & Rothbard, 2000); Social cognitive theory (Bandura, 1986) | *N* = 359 mother – child dyads (United States)  Two-wave longitudinal survey study  Structural equation modeling  Control variables: Maternal education, maternal income, child gender | Time and strain-based job demands are negatively associated with maternal physical activity  Maternal physical activity is positively associated with child physical activity |
| Jones et al. (2007), *Journal of Applied Psychology* | Job demands – control model (Karasek, 1979) | *N* = 420 employees of a government organization (England)  Daily diary study (7-days)  Multilevel random coefficients regression | Longer working hours were associated with a reduced likelihood of exercise in women  Negative affect was related to a reduced likelihood of exercise in men  Higher levels of chronic job demands were associated with a lower likelihood of exercise in men  Negative affect had a stronger effect on the likelihood of exercise for men in low-support jobs compared to high-support jobs  Negative affect has a stronger effect on the likelihood of exercise for men in low-demand jobs relative to high-demand jobs  Negative affect has a stronger effect on the likelihood of exercise for men in high-control jobs relative to low-control jobs |
| Kivimäki, Kuisma, Virtanen, & Elovainio (2001), *Work & Stress* | None | *N* = 506 shift-working and 183 day-shift working nurses (Finland)  Cross-sectional survey  Logistic regression | No evidence that sedentary lifestyle was more prevalent in shift workers compared to day workers  Sedentary lifestyle was measured as the frequency and intensity of leisure time physical activity |
| Magnini, Lee, & Kim (2011), *International Journal of Contemporary Hospitality Management* | Emotional intelligence framework (Mayer & Salovey, 1997) | *N* = 210 hotel department managers (South Korea)  Cross-sectional survey  Structural equation modeling | Hotel worker’s hours of exercise were found to positively predict emotional intelligence  Theorized a cascading process whereby exercise hours predict emotional intelligence, which predicts affect- and cognition-based trust, which predicts job satisfaction, which predicts organizational commitment. However, no test of mediation was reported. |
| Mazzola, Moore, & Alexander (2017), *Stress and Health* | Theory of Planned Behavior (Ajzen, 1991) | *N* = 93 employees (United States)  Daily survey study (5-days)  Multilevel random coefficients regression | Potential workplace barriers and facilitators to exercise were coded by the authorship team  Barriers included workload, nonwork factors, time constraints, fatigue, physical ailments, work environment, social influences, temptation, availability of exercise options, and knowledge / awareness  Facilitators included time availability, making healthy decision, work environment, social support, planning, motivation / disposition, availability of healthy options, proper sleep, workload, structured schedule, and knowledge / awareness  Multilevel results showed that exercise barriers and facilitators influenced exercise behavior  Exploratory results were suggestive of the possibility that facilitators play a stronger role than barriers in healthy behavior |
| Moisan et al. (1999), *Work & Stress* | None | *N* = 1,110 public sector employees (Canada) | Sedentary employees reported a higher likelihood of psychotropic drug use, relative to active employees |
| Mudrack (1992), *Journal of Organizational Behavior* | Protestant work ethic framework (Beit-Hallahmi, 1979) | *N* = 335 employees  Cross-sectional survey  Spearman rank-order correlation | Use of a fitness center and protestant work ethic are positively correlated  Protestant work ethic positively predicts fitness center use incrementally above sex, age, organizational tenure, and stress |
| Murphy et al. (2002), *International Journal of Stress Management* | Ecological models (e.g., Bronfenbrenner, 1977) | *N* = 441 male firefighters  Cross-sectional survey (although the author’s refer to it as a “longitudinal, prospective study”)  Stepwise multiple regression | 41% of participants reported that they exercised in their leisure time 3 to 4 days per week |
| Payne et al. (2002), *Journal of Occupational Health Psychology* | Theory of planned behavior (Ajzen, 1991) | *N* = 241 employees of a computer hardware and software company (United Kingdom)  Two-wave longitudinal survey  Hierarchical multiple regression / one-way ANOVA | Exercise attitudes and norms predict exercise intentions after controlling for age and sex  Exercise intentions and exercise self-efficacy predict exercise behaviors  Internal barriers to exercise and work barriers to exercise negatively predict exercise self-efficacy, while job flexibility positively predicts exercise self-efficacy  Employees in high strain jobs report less exercise self-efficacy and less perceived controllability over exercise than employees in low strain jobs  Employees in high strain jobs report participating in less exercise than employees in low strain jobs, despite that similar intentions to exercise |
| Shukri et al. (2016), *Stress and Health* | Theory of planned behavior (Ajzen, 1991) | *N* = 603 employees (United Kingdom, Malaysia)  Cross-sectional survey across two sites (focused on cross-cultural differences)  Stepwise multiple regression | UK participants were less likely to intend to engage in physical activity than Malaysian participants  Exercise attitudes were a significant positive predictor of physical activity intentions for UK participants only  Descriptive norms were significant positive predictors of physical activity intentions for Malaysian participants  Exercise attitudes, self-efficacy, and perceived control fully mediated the relationship linking job resources to physical activity intentions |
| Sliter & Sliter (2014), *International Journal of Stress Management* | None | *N* = 228 undergraduate and graduate students, all employed at least part-time outside of school (United States)  In-lab cross-sectional survey with resting heart rate assessment  Pearson bivariate correlation | Greater physical activity correlates negatively with physical health problems, stress, BMI, and resting heart rate  Greater physical activity correlates positively with gym attendance  Vigorous and muscle strengthening activities were more strongly correlated with BMI than light and moderate aerobic activity  Moderate aerobic activity correlated more strongly with stress than other forms of exercise |
| Thøgersen-Ntoumani & Fox (2005), *Work & Stress* | None | *N* = 1529 employees of a large multi-national IT company (England)  Cross-sectional survey  Cluster analysis | Employees cluster into *self-assured* (high life satisfaction, very highly satisfied with physical aspects of themselves), *unhappy* (very dissatisfied with life, low self-worth), *exercising happy* (very physically active, satisfied with their lives), and *physically unhappy employees* (overweight, low physical self-worth and physical satisfaction)  Exercise was very central to the lives of the *exercising happy* group |
| Tsai et al. (2014), *Journal of Occupational Health Psychology* | Job demands – control model (Karasek, 1979) | *N* = 825 long-haul bus drivers (Taiwan)  Cross-sectional survey with blood draw  Independent samples *t*-tests, ANOVAs, hierarchical logistic regression | Static activity during leisure time (i.e., inactivity) was associated with greater plasma concentration of high sensitivity C-reactive protein, an inflammation marker |
| Tsaousis & Nikolaou (2005), *Stress and Health* | Emotional intelligence framework (Mayer & Salovey, 1997) | *N* = 212 employees of a mental health institution (Study 2)  Cross-sectional survey  Pearson bivariate correlation | Emotional intelligence is positively correlated with the frequency of planned exercise |

**TABLE A2**

**STUDIES EVALUATING PHYSICAL ACTIVITY IN RELATION TO WORK RECOVERY**

|  |  |  |  |
| --- | --- | --- | --- |
| Authors (Year), Journal | Primary Theoretical Foundation(s) | Sample, Design, Analyses | Main Findings |
| Bakker et al. (2013), *Journal of Organizational Behavior* | Effort – recovery model (Meijman & Mulder, 1998) | *N* = 85 employees (Netherlands)  Daily diary study (day reconstruction method)  Hierarchical linear modeling | Spending more evening time on sports / exercise is positively predictive of evening happiness, momentary vigor, and momentary recovery before going to sleep  The relationship of evening sports / exercise time with evening happiness and momentary recovery before going to bed is stronger for employees reporting high workaholism, relative to low workaholism |
| Cho & Park (2018), *Stress and Health* | Effort – recovery model (Meijman & Mulder, 1998) | *N* = 70 working students (United States)  Longitudinal study (5 weekly surveys on Friday afternoons and Monday mornings)  Multilevel path analysis | When individuals experience high psychological detachment during the weekend, weekend physical activity is associated with lower Monday negative affect  When individuals experience low psychological detachment during the weekend, weekend physical activity is associated with higher Monday morning negative affect  Physical activity was associated with lower Monday negative affect when participants reported greater weekend sleep hours, but not when they reported higher weekend sleep hours |
| Feuerhahn et al. (2014), *European Journal of Work and Organizational Psychology* | Effort – recovery model (Meijman & Mulder, 1998); Self-determination theory (Ryan & Deci, 2000) | *N* = 126 employees working at least 20 hours per week (Germany)  Daily diary study (5-days, twice per day)  Hierarchical linear modeling | Post-work exercise activities were positively related to evening positive affect  Post-work exercise activities were positively related to evening psychological detachment  Engaging in post-work exercise activities with others was positively related to a sense of belonging  Post-work exercise activities were positively related to bodily attractiveness and sports competence  Psychological detachment, sense of belonging, bodily attractiveness, and sports competence partially mediate the relation between post-work exercise activities and positive affect |
| Nägel et al. (2015), *International Journal of Stress Management* | Self-control theory (e.g., Muraven & Baumeister, 2000) | *N* = 120 employees  Daily survey study (Five consecutive working days)  Random coefficient modeling | Person-level revitalization motives surrounding exercise predicted daily exercise after work  For individuals reporting a strong motive for social recognition, a strong motive for appearance, and a strong motive for strength and endurance surrounding exercise, day-specific job stressors were positively related to day-specific exercise after work  Day-specific exercise after work positively predicted positive activated affect at bedtime and day-specific serenity at bedtime |
| Oerlemans & Bakker (2014), *Journal of Occupational Health Psychology* | Job demands – resources model (Bakker & Demerouti, 2007); Effort – recovery model (Meijman & Mulder, 1998) | *N* = 287 employees (Netherlands)  Daily diary study (day reconstruction method)  Hierarchical linear modeling | Off-job time spent on physical activities was positively associated with state physical vigor and state cognitive liveliness during off-job time  Off-job time spent on physical activities was positively associated with state physical recovery at bedtime  No evidence obtained that person-level burnout moderated the relationships of off-job time spent on physical activities with state physical vigor, state cognitive liveliness, or state physical recovery |
| Oerlemans et al. (2014), *Work & Stress* | Effort – recovery model (Meijman & Mulder, 1998); Conservation of resources theory (Hobfoll, 1989); Broaden-and-build theory (Fredrickson, 2001) | *N* = 384 employees (Netherlands)  Daily diary study (day reconstruction method)  Hierarchical linear modeling | On days when individuals spent more off-job time on physical activities, they felt more recovered when the experience of happiness during these activities was high |
| Rook & Zijlstra (2006), *European Journal of Work and Organizational Psychology* | Effort – recovery model (Meijman & Mulder, 1998) | *N* = 46 employees  Daily diary study (7-days)  *t*-tests and repeated measures ANOVAs / Multiple regression | Time spent on physical activities after work is negatively related to fatigue |
| Sianoja et al. (2018), *Journal of Occupational Health Psychology* | Effort – recovery model (Meijman & Mulder, 1998) | *N* = 97 employees working in knowledge intensive and emotionally-demanding jobs  Experiment (within-person design; 2 days a week for 5 weeks)  Multilevel modeling (note: did not test causal processes, as control group was excluded) | A within-workday park walking break was positively associated with afternoon concentration via enjoyment  A within-workday park walking break was negatively associated with afternoon strain |
| Sonnentag (2001), *Journal of Occupational Health Psychology* | Effort – recovery model (Meijman & Mulder, 1998); Conservation of resources theory (Hobfoll, 1989) | *N* = 100 school teachers (Netherlands)  Daily diary study (5-days)  Hierarchical linear modeling | Post-work time spent on physical activities had a positive impact on well-being at bedtime |
| Sonnentag & Jelden (2009), *Journal of Occupational Health Psychology* | Self-control theory (Muraven & Baumeister, 2000) | *N* = 78 police employees (Germany)  Daily diary study (5-days)  Random coefficients modeling | Situational constraints at work were negatively associated with the amount of time spent on sports activities during off-job time  Developing more of a routine for off-job time was positively related to the amount of time spent on sports activities during off-job time  Resources for self-regulation mediate the relation between situational constraints and time spent on sports activities during off-job time  Assumed and experienced recovery were higher after having performed sports activities during off-job time, relative to performing low-effort activities during off-job time |
| ten Brummelhuis & Bakker (2012), *Journal of Occupational Health Psychology* | Effort – recovery model (Meijman & Mulder, 1998); COR theory (Hobfoll, 1989) | *N* = 74 nurses (Netherlands)  Daily survey study (5-days)  Multilevel modeling | Off-job physical activities correlate positively with next-morning vigor via increased psychological detachment  Off-job physical activities were positively related to next-day work engagement through enhanced next-morning vigor |
| Van Hooff et al. (2019), *Journal of Occupational Health Psychology* (Study 1) | Effort – recovery model (Meijman & Mulder, 1998); Distraction hypothesis (Yeung, 1996) | *N* = 74 employees working at least 24 hours per week who typically engage in physical exercise after work at least twice a week  Daily diary study (10-days)  Multilevel path analysis | Time spent on strenuous leisure time physical activity is positively associated with off-job psychological detachment  Time spent on strenuous leisure time physical activity is associated with negative and positive activation at bedtime and the next morning via off-job psychological detachment  No evidence that time spent on moderate and mild leisure time physical activity are associated with psychological detachment |
| Volman et al. (2013), *European Journal of Work and Organizational Psychology* | Effort – recovery model (Meijman & Mulder, 1998); Conservation of resources theory (Hobfoll, 1989) | *N* = 65 employees (Netherlands)  Daily diary study (5-days)  Multilevel analysis | Off-job physical activities positively relate to self-family facilitation  No evidence to link off-job physical activities to psychological detachment |

**TABLE A3**

**STUDIES EVALUATING PHYSICAL ACTIVITY AS A MODERATOR**

|  |  |  |  |
| --- | --- | --- | --- |
| Authors (Year), Journal | Primary Theoretical Foundation(s) | Sample, Design, Analyses | Main Findings |
| Barber et al. (2017), *Journal of Applied Psychology* | Self-control theory (Muraven & Baumeister, 2000) | *N* = 118 MBA students who work full-time (United States)  Longitudinal surveys (2 time points) with actigraphy across one week  Multiple regression | The indirect effect of supervisor undermining on home undermining via subjective sleep quality was observed at low levels of self-reported exercise, daily steps, and energy expenditure, but not at high levels |
| Burton et al. (2012), *Journal of Business and Psychology* | Effort – recovery model (Meijman & Mulder, 1998) | *N* = 98 MBA students who worked full-time (United States)  Multi-source cross-sectional survey (supervisor – subordinate dyads)  Hierarchical multiple regression | The relationship of supervisor perceptions of stress and employee perceptions of abusive supervision is stronger for supervisors who exercise less frequently |
| Sawhney et al. (2018), *Journal of Occupational Health Psychology* | Effort – recovery model (Meijman & Mulder, 1998); Conservation of resources (Hobfoll, 1989) | *N* = 268 firefighters (United States)  Longitudinal study (2 surveys)  Multiple regression | Occupational stress was more strongly positively related to mental health symptoms when firefighters engaged in low exercise, relative to high exercise |
| Sliter et al. (2014), *International Journal of Stress Management* | Effort – recovery model (Meijman & Mulder, 1998); Conservation of resources theory (Hobfoll, 1989) | *N* = 152 registered nurses (United States)  Cross-sectional survey  Hierarchical multiple regression | The positive relationships of staff demands and patient-related stressors with depression were weaker for those higher in physical activity, relative to those lower in physical activity  The negative relationships of workload and staff demands with work engagement were weaker for those higher in physical activity, relative to those lower in physical activity  The negative relationship between workload and life satisfaction was weaker for those higher in physical activity, relative to those lower in physical activity |
| Toker & Biron (2012), *Journal of Applied Psychology* | Effort – recovery model (Meijman & Mulder, 1998); Conservation of resources theory (Hobfoll, 1989) | *N* = 2,214 employees who attended three routine employer-sponsored health examinations  Longitudinal study (3 waves)  Latent difference scores using structural equation modeling | Higher physical activity attenuated increases of job burnout on subsequent depression  Higher physical activity attenuated increases in depression on subsequent job burnout |

**TABLE A4**

**STUDIES EVALUATING THE EFFECTIVENESS OF PHYSICAL ACTIVITY INTERVENTIONS**

|  |  |  |  |
| --- | --- | --- | --- |
| Authors (Year), Journal | Primary Theoretical Foundation(s) | Sample, Design, Analyses | Main Findings |
| Atlantis et al. (2006), *Journal of Occupational Health Psychology* | None | *N* = 73 casino employees working a variety of shift types (Australia)  Experiment (24 week supervised exercise participation with health education counseling vs. wait-list control)  ANCOVA | Participants assigned to a 24 week supervised exercise prescription with health education counseling reported better sleep quality relative to controls, with these effects more pronounced in women  This pattern of results held for shift workers but not for non-shift workers |
| Bruning & Frew (1987), *Journal of Applied Psychology* | Physiologically-based perspectives to stress (e.g., Selye, 1956) | *N* = 86 hospital-equipment facility employees (United States)  Experiment (six months of management skills, meditation, exercise, or control self-guided exercises)  ANCOVA | Management skills, meditation, and exercise group participants showed reductions in systolic blood pressure over the intervention, but differences were not more pronounced for any one condition |
| Budden & Sagarin (2007), *Journal of Occupational Health Psychology* | Theory of planned behavior (Ajzen, 1991) | *N* = 274 employees  Experiment (exercise intention implementation exercise vs. control)  Hierarchical multiple regression | Attitude toward exercise, subjective normative influence to exercise, and perceived behavioral control predict exercise intention  The predictive validity of perceived behavior control on exercise intention increased when (1) attitude toward exercise and subjective normative influence to exercise were high and (2) when attitude toward exercise was low and subjective normative influence to exercise was high  Occupational stress was negatively related to exercise  Perceived behavioral control fully mediated the relationship between occupational stress and exercise intention  Exercise intention distinguished whether people engaged in exercise behavior  Those who formed an implementation intention were less likely to exercise than those who did not |
| Clark et al. (2014), *Stress and Health* | None | *N* = 84 members of a worksite wellness center  Pre-post evaluation with one month follow-up (12-week studio cycling intervention; no control group)  Paired *t*-tests | Perceived stress and current health status improved post-intervention and was maintained at one-month follow-up  The post-intervention reduction in perceived stress was larger for men than women, although this difference was not observed at one-month follow-up |
| Daley & Parfitt (1996), *Journal of Occupational and Organizational Psychology* | None | *N* = 293 head office employees of a food retail company (United Kingdom)  Quasi-experiment (company health and fitness club members, non-members, and on a wait-list to join)  Pearson correlation / MANCOVA | Physical activity and fitness were positively correlated  Fitness club members reported higher physical activity, energy, elation, clear-headedness, confidence, and job satisfaction than both non-members and wait-list employees  Fitness club members exhibited greater physical fitness at a health screening than non-members and wait-list employees  Fitness club members reported being more composed and agreeable than non-members  Fitness club members exhibited lower absenteeism than non-members |
| Gubler et al. (2018), *Management Science* | Reciprocity theory (e.g., Grant & Gino, 2010) | *N* = 111 laundry plant workers  Quasi-experiment (four plants participating in wellness program vs. single non-participating plant)  Ordinary least squares regression | Wellness program participants who complied with the program improved their productivity by 3.9%  Wellness program participation gains were found to be driven by improvements in exercise, nutrition, and stress |
| Kerr & Vlaswinkel (1995), *International Journal of Stress Management* | Arousal-based motivation models (e.g., Apter, 1982) | *N* = 76 professional bank employees (Netherlands)  Quasi-experiment (regular employee fitness program participants, irregular employee fitness program participants, regular exercisers not in employee fitness program, non-exercisers)  ANOVA | Regular and irregular employee fitness program participants were absent less frequently than members of the other two control groups  These differences largely extended from a difference in long-term (i.e., more than 2 days) absence between the fitness program vs. non-fitness program participant groups  Non-exercisers reported feeling more worn out than the other groups |
| Lennefer et al. (2020), *Journal of Occupational Health Psychology* | None | *N* = 116 physically inactive, at risk employees (Germany)  Randomized control trial (activity tracker with online coaching vs. wait-list control) across three weeks  ANOVA / ANCOVA | Members of the intervention group showed increased physical activity after the intervention, relative to control group participants  Inactive employees benefited from the intervention more than active employees  A reduction in burnout 1 month after the intervention was observed for the intervention group, but the effect did not persist 3 months and 1 year later  An increase in health perceptions for the treatment group was observed after the intervention period, at 1 month, and at 3 months, but not after 1 year  A reduction in BMI was observed for the intervention group that was durable 1 year later |
| Patterson et al. (2005), *Journal of Business and Psychology* | Self-control theory (Muraven & Baumeister, 2000) | *N* = 539 employees of small business in industries at high risk for alcohol or drug abuse (United States)  Experiment (team awareness training, health promotion choices training, control)  Multiple regression | Both team awareness training and health promotion choices training improved positive unwinding (of which exercise is one of numerous elements comprising this variable) |
| Pedersen et al. (2019), *Journal of Occupational Health Psychology* | Self-determination theory (Ryan & Deci, 2000) | *N* = 202 employees (Norway)  Pre-post cluster randomized controlled trial (group physical activity workshops and support group vs. delayed intervention control group)  ANOVA | Intervention group participants exhibited fewer somatic complaints  Change in autonomous motivation for physical activity was positively associated with changes in physical activity |
| Ranby et al. (2011), *Journal of Occupational Health Psychology* | Social cognitive theory (Bandura, 1986); Health belief model (Rosenstock, 1974) | *N* = 397 firefighters (United States)  Experiment (PHLAME team intervention vs. control group)  ANCOVA / path analysis | Knowledge of exercise benefits and exercise support from coworkers were positively associated with self-reported exercise  No evidence that the intervention influenced self-report exercise directly |
| Schwetschenau, O’Brien, Cunningham, & Jex (2008), *Journal of Occupational Health Psychology* | Learning theory (Haynes & O’Brien, 2000); Decisional balance theory (Marcus, Pinto, Simkin, Audrain, & Taylor, 1994) | *N* = 88 health-care service corporation employees  Quasi-experiment (corporate fitness center member vs. non-member)  Hierarchical and logistic regression | External barriers to exercise predicted corporate fitness membership, with the most salient external barrier identified as cost of membership  Internal barriers to exercise predicted the frequency of fitness center use  External barriers to exercise predicted the duration of fitness center visits, with the most salient external barrier being the perceived inadequacy of the facility |
| Throne et al. (2000), *International Journal of Stress Management* | None | *N* = 41 firefighters (United States)  Experiment (16 weeks of rowing training vs. no intervention control)  ANOVA | VO2max increased over time for the training group, relative to the control group  Mean arterial pressure, heart rate stress reactivity, self-reported negative affect, and self-reported anxiety decreased over time for the training group, relative to the control group |
| Wollseiffen et al. (2016), *Stress and Health* | Limited cognitive resource models (e.g., Kahneman, 1973) | *N* = 50 office employees  Experiment (massage chair, biking, boxing, usual break, working without a break)  ANOVA | Heart rate increased from pre-intervention to post-intervention for the biking, boxing, and usual break conditions  Mental arithmetic and attentional performance improved in the boxing condition relative to the usual break and massage chair conditions  Prefrontal alpha-2 activity was increased after boxing and biking, relative to the usual break and no break  Perceived physical fitness was higher in the usual break condition relative to the biking, boxing, and no break conditions |

**TABLE A5**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY, CARDIOVASCULAR DISEASE, AND DIABETES**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Warburton et al. (2006), *Canadian Medical Association Journal* | 3035 | This narrative review concludes that there is irrefutable evidence of the effectiveness of regular physical activity in the primary prevention (reducing risk in healthy individuals) and secondary prevention (reducing symptoms in unhealthy individuals) of several chronic diseases (e.g., cardiovascular disease, diabetes, breast and colon cancer, hypertension, obesity, depression and osteoporosis) and premature death. An average  energy expenditure of about 1000 kcal (4200 kJ) per week is associated with a 20%–30% reduction in all-cause mortality, but preliminary research suggests that half of this volume may be effective for individuals who are extremely deconditioned or frail. |
| Petersen & Pedersen (1998), *Journal of Applied Physiology* | 1420 | The authors review research suggesting that exercise has an anti-inflammatory effect, which explains why exercise can protect against chronic diseases associated with low-grade inflammation (e.g. diabetes and CVD). During exercise, muscle fibers produces IL-6, a myokine. IL-6 trigger other anti-inflammatory cytokines and inhibits the production of the proinflammatory cytokine TNF-alpha, the driver of insulin resistance and dyslipidemia. In addition, IL-6 enhances lipid turnover. |
| Powell et al. (1987), *Annual Review of Public Health* | 1044 | This systematic review concludes that the literature supports the inference that physical  activity is inversely and causally related to the incidence of Coronary Heart Disease (CHD). Physical activity could reduce the incidence of CHD by slowing the atherosclerotic process, modifying the structure of the coronary arteries, reducing vasospasm, enhancing myocardial electrical stability, or increasing fibrinolysis. Exercise improves glucose tolerance and insulin sensitivity, assists in weight control, and may lower blood pressure. |
| Berlin & Colditz (1990), *American Journal of Epidemiology* | 877 | This meta-analysis finds a relative risk of death from coronary heart disease of 1.9  (95% confidence interval 1.6-2.2) for sedentary compared with active occupations. This association is generally stronger when the "high activity" group in a study is compared with a sedentary group rather than when the comparison group has a moderate activity level. This pattern of association supports a dose-response relation between physical activity and protection from CHD. |
| Pedersen & Hoffman-Goetz (2000), *Physiological Reviews* | 839 | This review focuses on mechanisms underlying exercise-induced immune changes such as neuroendocrinological factors including catecholamines, growth hormone, cortisol, b-endorphin, and sex steroids. The available evidence shows that exercise can regulate immune responses and possibly improve immune function. These effects are mediated by diverse factors including exercise-induced release of proinflammatory cytokines, classical stress hormones, and hemodynamic effects leading to cell redistribution. |
| Goodyear & Kahn (1998), *Annual Review of Medicine* | 651 | Extensive epidemiological evidence demonstrates that long-term regular physical exercise can significantly reduce the risk of developing non insulin-dependent diabetes mellitus. Exercise activates glucose uptake by the contracting skeletal muscle. Frequent exercise training contributes to an increase in the responsiveness of muscle glucose uptake to insulin. |
| Bassuk & Manson (1999), *Journal of Applied Physiology* | 363 | This review of epidemiological studies suggest that physically active individuals have a 30–50% lower risk of developing type 2 diabetes and CVD than do sedentary persons. Risk reductions are observed with as little as 30 min of moderate-intensity activity per day. Protective mechanisms of physical activity include the regulation of body weight; the reduction of insulin resistance, hypertension, atherogenic dyslipidemia, and inflammation; and the enhancement of insulin sensitivity, glycemic control, and fibrinolytic and endothelial function. |
| Reiner et al. (2013), *BioMed Central Public Health* | 354 | The purpose of this review is to summarize existing evidence for the long-term (>5 years) relationship between physical activity and weight gain, obesity, coronary  heart disease, type 2 diabetes mellitus, Alzheimer’s disease, and dementia. A meta-analysis of 15 longitudinal studies shows that physical activity appears to have a positive long-term influence on all selected diseases. |
| Durstine et al. (2001), *Sports Medicine* | 332 | Regular weekly exercise can favorably alter blood lipids at low training volumes. Exercise that elicits between 1200 to 2200 kcal/week can increase 2 to 3 mg/dl in high-density lipoprotein cholesterol (HDL-C) and reduce triglycerides (TG) with 8-20 mg/dl while also reducing total cholesterol and low-density lipoprotein cholesterol (LDL-C). |
| Kodama et al. (2007), *Archives of Internal Medicine* | 271 | This review of 25 studies concludes that regular aerobic exercise modestly increases  HDL-C level. Exercise duration per session was positively related to increases in HDL-C levels. Exercise was more effective in subjects with initially high total cholesterol levels or low body mass index. |
| Roberts & Barnard (1998), *Journal of Applied Physiology* | 263 | Based on this review, the authors conclude that there is overwhelming evidence that physical activity and diet can reduce the risk of developing numerous chronic diseases, including CVD, hypertension, diabetes, metabolic syndrome, and several forms of cancer. Proposed mechanisms that explain the beneficial effects of exercise are enhanced insulin sensitivity, reduced inflammation, oxidative stress and an improved lipid profile, which in turn reduces obesity, adhesion, and blood clotting and enhances endothelial function. |
| Seals et al. (2008), *Journal of Applied Physiology* | 191 | Habitual physical activity/increased aerobic exercise capacity is associated with reduced risk of CVD. Compared with their sedentary peers, adults who regularly perform aerobic exercise demonstrate smaller or no age-associated increases in large elastic artery stiffness, reductions in vascular endothelial function, and increases in femoral artery intima medium wall thickness. |

**TABLE A6**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY AND GENERAL HEALTH**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Kohrt et al. (2004), *Medicine and Science in Sports and Exercise* | 447 | Weight-bearing physical activity has beneficial effects on bone health  across the age spectrum. Physical activities that generate relatively high-intensity loading forces, such as plyometrics, gymnastics, and high-intensity  resistance training, augment bone mineral accrual. Maintaining a vigorous level of physical activity across the lifespan should be viewed as an essential component of the prescription for achieving and maintaining good bone health. |
| Bize et al. (2007) *Preventive Medicine* | 437 | Cross-sectional studies, cohort studies, and randomized controlled trials tend to show a positive effect of physical activity on health-related quality of life (HRQL). HRQL encompasses perceived, valued health attributes such as a sense of comfort or well-being, the ability to maintain good physical, emotional, and intellectual functions, and the ability to satisfactorily take part in social activities. |
| Hayden et al. (2005), *Annual Internal Medicine* | 412 | This review of 43 randomized controlled trials concluded that exercise therapy that consists of individually designed programs, including stretching or strengthening, that is  delivered with supervision may improve pain and function in chronic nonspecific low back pain. |
| Samitz et al. (2011), *International Journal of Epidemiology* | 364 | This review of 80 studies concludes that higher levels of total (Risk Ratio (RR) = .65) and leisure time physical activity (RR = .74) were associated with reduced all-cause mortality. Risk reduction per 1-hour increment of exercise per week increase was largest for vigorous exercise (RR = .91). Moderate-intensity activities of daily living were to a lesser extent beneficial in reducing mortality (RR = .96). RRs corresponding to 15- and 300 min/week of moderate to vigorous activity were .86 and .74 respectively. Mortality reductions were more pronounced in women. |
| Driver & Taylor (2000)*, Sleep Medicine Reviews* | 307 | Although only moderate effect sizes have been noted, meta-analytical techniques have shown that exercise yields increased total sleep time and delayed REM sleep onset (10 min), increased slow-wave sleep (SWS), and reduced REM sleep (2–5 min). |
| Kredlow et al. (2015) | 175 | This meta-analysis reveals that acute exercise has small beneficial effects on total sleep time, sleep onset latency, sleep efficiency, stage 1 sleep, and slow wave sleep, a moderate beneficial effect on wake time after sleep onset, and a small effect on REM sleep. Regular exercise has small beneficial effects on total sleep time and sleep efficiency, small-to-medium beneficial effects on sleep onset latency, and moderate beneficial effects on sleep quality. |

**TABLE A7**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY AND MENTAL HEALTH**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Salmon (2001), *Clinical Psychological Review* | 574 | This narrative review concludes that there is overwhelming evidence confirming that exercise improves mood when mood has been measured immediately before and after regular exercisers undertake strenuous exercise at a level with which they are familiar.  Exercise that is more intense than participants’ habitual level is less likely to improve  mood and may worsen it. Exercise at competitive levels can worsen mood in habitual exercisers, and strenuous exercise in people who are not selected for having intense exercise habits has commonly, although not invariably, increased negative mood or decreased positive mood. Cross-sectional studies have consistently associated high self reported levels of habitual exercise (aerobic and anaerobic) with better mental health (lower depression and anxiety). There is also some evidence that regular exercisers experience less life stress, and have a better stress response; their heart rate and blood pressure during recovery from a stressor are lower. The neurochemical process through which exercise is beneficial are enhanced norepinephrine and activation of opioid systems. |
| Strohle (2009), *Journal of Neural Transmission* | 479 | This narrative review concludes that there is convincing evidence for reduced incidence rates of depression and various anxiety disorders in subjects who exercise. |
| Paluska & Schwenk (2000), *Sports Medicine* | 464 | Increased aerobic exercise or strength training has been shown to reduce depressive symptoms significantly. Anxiety symptoms and panic disorder also improve with regular exercise. Proposed psychological mechanisms that explain the beneficial effect of exercise on mental health are distraction, enhanced self-efficacy, mastery, and increased social relations. Proposed physiological mechanisms include enhanced transmission of monoamines (e.g., dopamine, serotonin) and endorphins that reduce pain and potentiate a euphoric state. |
| Teychenne et al. (2008), *Preventive Medicine* | 377 | This narrative review of 67 studies finds that both shorter and longer durations of physical activity are associated with a reduced likelihood of depression. There is also evidence that vigorous intensity physical activity is more strongly associated with decreased likelihood of depression than lower intensities. The authors conclude that although the dose and domain of physical activity varied across studies reviewed, evidence suggests that even low doses of physical activity may be protective against depression. |
| Mammen & Faulkner (2013), *American Journal of Preventive Medicine* | 334 | This systematic review of 30 studies found that 25 studies demonstrated that baseline  physical activity was negatively associated with a risk of subsequent depression. There is promising evidence that any level of physical activity, including low levels (e.g., walking < 150 minutes/weeks), can prevent future depression. |
| Scully et al. (1998) *British Journal of Sports Medicine* | 330 | Exercise regimens extended over several months are observed to reduce depression. Aerobic exercise such as walking, jogging, cycling and light weight training seems most effective. Short bursts of exercise of any nature are effective in reducing anxiety. There is also evidence for increases in stress responsivity among individuals who engage in aerobic exercise three times a week for longer than 21 minutes. Exercise has also been related to enhanced mood states and self-esteem. Less strenuous forms of non-competitive exercise have been related to reduced symptoms of pre-menstrual syndrome. |
| Reed & Ones (2006), *Psychology of Sports and Exercise* | 217 | This meta-analysis of 158 studies examined the effect of acute aerobic exercise on self reported positive affect (PA). Effects were consistently positive (a) immediately post-exercise, (b) when pre-exercise PA was lower than average, (c) for low intensity exercise of 15–39% oxygen uptake reserve (%VO2R), (d) for durations up to 35 min, and (e) for low to moderate exercise doses. The effects of aerobic exercise on PA appear to last for at least 30 min after exercise before returning to baseline. |
| Chaouloff (1989), *Acta Physiology Scandinavia* | 195 | This review discussed the physiological processes that may explain why physical activity has been reported to reduce depression symptoms and anxiety, and to improve coping with stress. Research suggests that exercise increases the synthesis of central dopamine and noradrenaline, as well as serotonin. Dopamine is a hormone and neurotransmitter that plays a major role in the motivational component of reward-motivated behavior (e.g., telling the brain the desirability or aversiveness of an outcome to then propel behavior to or away from that outcome). Noradrenaline is a hormone and neurotransmitter which generally functions to mobilize the brain and body for action. Serotonin is an important chemical and neurotransmitter that is believed to help regulate mood and social behavior, appetite and digestion, sleep, memory, and sexual desire and function. |
| Yeung (1996), *Journal of Psychosomatic Research* | 187 | This narrative review of research on the relationship between exercise and mood concludes that both clinical and nonclinical subjects may benefit acutely from even a single bout of exercise. Suggested mechanisms of the positive effect of exercise on mood are enhanced endorphins, elevation of body temperature, distraction, and feelings of mastery. |
| Taylor et al. (2007), *Addiction* | 164 | This systematic review of 14 studies concludes that relatively small doses of exercise reduce cigarette cravings, withdrawal symptoms, and negative affect between 5 to 50 minutes after exercise. |
| Hausenblas & Fallon (2006), *Psychology & Health* | 160 | This meta-analysis of 121 studies concludes that exercise is associated with improved body image. Small effect sizes indicated that: (a) exercisers had a more positive body image than non-exercisers; (b) exercise intervention participants reported a more positive  body image post intervention compared to the non-exercising control participants; and (c) exercisers had a significant improvement in body image scores following an exercise intervention. |

**TABLE A8**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY AND COGNITIVE PERFORMANCE**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Hillman et al. (2008), *Nature Reviews Neuroscience* | 1423 | There is a dearth of cross-sectional research on exercise cognition effects in young adults. Findings from neuro-imaging studies suggest that physical activity influences baseline electrocortical function and that greater amounts of physical activity or aerobic fitness are generally beneficial to cognitive processes that are related to the allocation of attentional resources and faster cognitive processing during stimulus encoding. Studies with animals have revealed that fitness training enhances angiogenesis, synaptogenesis,  and neurogenesis (in the dentate gyrus of the hippocampus), as well as the upregulation of a number of neurotrophic factors in the mouse brain that improve cognitive function. |
| Smith et al., (2010), *Psychosomatic Medicine* | 658 | This meta-analysis of 29 randomized controlled studies demonstrated modest improvements in attention and processing speed (g = 0.158), executive function (g = 0.123), and memory (g = 0.128) in response to exercise. Aerobic exercise training is associated with modest improvements in attention and processing speed, executive function, and memory, although the effects of exercise on working memory are less consistent. |
| Chang et al. (2012), *Brain Research* | 497 | This meta-analysis of 79 studies assessed the short-term implications of exercise for cognitive performance indicators including information processing, reaction time, attention, crystalized intelligence, executive function, and memory. Analyses indicated that the overall effect of exercise was positive and small (g=0.097 n=1034). Positive and small effects were also found in all three acute exercise paradigms: during exercise (g=0.101), immediately following exercise (g=0.108), and after a delay (g=0.103). Benefits are larger for more fit individuals who perform the physical activity for 20 min or longer. Higher intensity exercise yields more durable effects that last after a delay. |
| Tomporowski (2003), *Acta Psychologica* | 464 | Submaximal aerobic exercise performed for periods of up to 60 min facilitates cognitive function (e.g., response speed, response accuracy, problem-solving, and goal-oriented action). However, extended exercise that leads to dehydration compromises both information processing and memory functions. |
| Lambourne & Tomporowski (2010), *Brain Research* | 389 | This meta-analysis concludes that during the first 20 min of exercise, cognitive task performance was impaired by a mean effect of Δ = -0.14. Otherwise, exercise-induced arousal enhanced performance on tasks that involved rapid decisions and automatized behaviors. Following exercise, cognitive task performance improved by a mean effect of Δ = 0.20. Arousal continued to facilitate speeded mental processes and also enhanced memory storage and retrieval. Cycling was associated with enhanced performance during and after exercise, whereas treadmill running led to impaired performance during exercise and a small improvement in performance following exercise. |
| Etnier et al. (1997), *Journal of Sport and Exercise Psychology* | 372 | A meta-analytic review showed that exercise has a small positive effect on cognition (i.e., response time; effect size = .25). Although the authors warn that weaknesses in the study design limit the robustness of observed findings, they cautiously conclude that exercise can improve cognitive performance as measured by a wide variety of cognitive tests (e.g., reaction time, line matching tests, verbal comprehension tests, the Culture Fair Intelligence Test, the Stanford-Binet Intelligence Quotient, the Weschler Memory Scale, the Steinberg Number Task, the Stroop test, and Raven's Progressive Matrices Test). |
| Etnier et al. (2006), *Brain Research* | 367 | This meta-analysis of 39 studies examined if changes in aerobic fitness relate to changes in cognitive function. Results from cross-sectional studies indicated that there was not a significant linear or curvilinear relationship between the effect sizes of fitness and cognitive function. Pre-post test studies, however, show there was a significant negative relationship between changes in aerobic fitness and changes in cognitive performance. These findings indicate that small gains in exercise were predictive of the largest improvements in cognitive exercise, whereas larger gains in aerobic fitness were predictive of lesser improvements in cognitive performance. |
| Kramer & Erickson (2007), *Cognitive Sciences* | 364 | Based on a critical review of epidemiological or prospective observational studies, randomized human clinical interventions, and non-human animal studies, the authors conclude that the literature supports the claim that physical activity enhances cognitive and brain function, and protects against the development of neurodegenerative diseases, through the reduction of disease risk, and in the improvement in the molecular and cellular structure and function of the brain. |
| Voss et al. (2011), *Journal of Applied Physiology* | 204 | Cross-sectional studies on the effect of aerobic exercise on cognitive function in young adults (20 – 59) show mixed findings. Studies that use neuroimaging and training, however, seem to support a positive association between greater aerobic fitness and brain function (i.e., attention focus, monitoring of conflict, and error awareness). There is a general void in the literature regarding the role of chronic resistance training in promoting cognitive and brain function in young adults. Mechanisms that explain the positive effect of aerobic exercise on cognitive function include the generation of new neurons (neurogenesis), growth of new blood vessels (angiogenesis), and the production of various neurochemicals that facilitate synaptic plasticity. These processes improve hippocampus functioning, facilitate the integration of hippocampal neurons into existing brain networks, and improve learning and memory. |

**TABLE A9**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY AND BRAIN PROCESSES**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Cotman et al. (2007), *Trends in Neuroscience* | 987 | Exercise has benefits for learning and memory due to increases in synaptic plasticity and strengthening of the underlying systems that support plasticity including neurogenesis, metabolism, and vascular function. A key mechanism mediating these broad benefits of exercise on the brain is induction of central and peripheral growth factors and growth  factor cascades, which instruct downstream structural and functional changes. In addition, exercise reduces several risks for diminished brain health (diabetes, hypertension, CVD, and inflammation). |
| Voss et al. (2013), *Trends in Cognitive Sciences* | 340 | This narrative review evaluates the influence of exercise on hippocampal structure and function, addressing common themes such as spatial memory and pattern separation, brain structure and plasticity, neurotrophic factors, and vasculature. Research shows that physical exercise improves hippocampal function indicators such as virtual navigation and pattern separation tasks. An important underlying cellular mechanism for the benefits of exercise for the brain is brain-derived neurotrophic factor (BDNF). BDNF is of particular interest because it supports neural survival, growth, and synaptic plasticity. Through these molecular and cellular processes, physical exercise can contribute to cognitive ability (e.g., executive functions, relational memory), real world function (e.g., academic or job performance, driving), and the delay and prevention of neurodegenerative diseases. |
| Van Praag (2008)*, Neuromolecular Medicine* | 334 | This narrative review discusses research that shows that neurogenesis in the hippocampus mediates the positive relationship between exercise and improved learning and memory. Exercise increases the number of new neurons and influences the morphology of individual newly born cells, suggesting that that the benefits of exercise for new neurons are qualitative as well as quantitative. In addition, research using microarray analysis has shown that both acute and chronic voluntary exercise upregulate the glutamatergic system (a fast-signaling system for information processing in neuronal networks of the neocortex and hippocampus) and downregulates the GABA system (which plays the role of inhibiting or reducing the activity of neurons or nerve cells). |
| Hotting & Roder (2013), Neuroscience and Biobehavioral Reviews | 237 | This narrative review suggests that cross-sectional and longitudinal cohort studies support beneficial effects of physical activity on cognitive capabilities (e.g., executive functions, memory, spatial learning, cognitive speed, attention, psychomotor functions) through various processes that facilitate neuroplasticity – the brain’s ability to adapt to changing demands, which results in learning and skill acquisition. Animal research has suggested that physical exercise induces a cascade of functional and structural changes in the nervous system including angiogenesis, dendritic spine density, an enhanced long-term potentiation, and an augmented release of growth factors like BDNF and the insulin-like growth factor-1. Aerobic exercise might also induce beneficial effects on brain functions via changes in blood flow and vascularization which would lead to an overall better oxygen and nutrition supply. Furthermore, physical exercise has been shown to affect neuro-transmitter systems by increasing levels of serotonin, noradrenalin, and acetylcholine or by enhancing cortical choline uptake and dopamine receptor density. These factors all play important roles in inducing neuroplasticity. |
| Szuhany et al. (2016), *Journal of Psychiatric Research* | 198 | Consistent evidence indicates that exercise improves cognition and mood, with preliminary evidence suggesting that brain-derived neurotrophic factor (BDNF) may mediate these effects. A meta-analysis of 29 studies examined the effect of exercise on BDNF levels in three exercise paradigms: (1) a single session of exercise, (2) a session of exercise following a program of regular exercise, and (3) resting BDNF levels following a program of regular exercise. Results demonstrated a moderate effect size for increases in BDNF following a single session of exercise (*g* = 0.46). Further, regular exercise intensified the effect of a session of exercise on BDNF levels (*g* = 0.59). Finally, results indicated a small effect of regular exercise on resting BDNF levels (*g* = 0.27). |
|  |  |  |

**TABLE A10**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY UNDER DIFFERENT CONDITIONS**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Pollock et al. (1998)  *Medicine & Science in Sports & Exercise* | 1957 | A well-rounded training program includes aerobic and resistance training, as well as flexibility exercises. To produce a training effect and obtain health benefits, it is recommended to exercise endurance training twice or more per week, in bouts of at least 10 minutes, at an intensity above 50% of the maximum heart rate. |
| Teixeira et al. (2012), International Journal of Behavioural Nutrition and Physical Activity | 657 | This systematic review of 66 empirical studies concludes that there is consistent support for a positive relation between more autonomous forms of motivation and exercise, with a trend towards identified regulation predicting initial/short-term adoption of exercise more strongly than intrinsic motivation, and intrinsic motivation being more predictive of long-term exercise adherence. The literature is also consistent in that competence satisfaction and more intrinsic motives positively predict exercise participation across a range of samples and settings. |
| Ekkekakis et al., (2011), *Sports Medicine* | 376 | This review of 33 articles shows that individuals experience positive affect at exercise intensity levels below the lactate threshold (when lactate starts to accumulate in the blood). Above this threshold, individuals experience negative affect. When the intensity of exercise is self-selected, rather than imposed, it appears to foster greater tolerance to higher intensity levels. The decision to engage in exercise is likely affected by the individual’s affective experience when exercising, and intensity levels and corresponding affective experiences from exercise should therefore be considered in exercise guidelines. |
| Hamer & Chida (2008), *Preventive Medicine* | 354 | This meta-analysis of 8 studies concludes that active commuting that incorporates walking and cycling was associated with an overall 11% reduction in cardiovascular risk,  which was more robust among women. |
| Blair et al. (1992), *Annual Review of Public Health* | 324 | Exercise physiologists have generally recommended relatively intensive activity and a formal approach to exercise prescription. However, the epidemiological studies suggest a linear dose-response relationship between physical activity and health and functional effects. These data support public health recommendations directed toward the most sedentary and unfit stratum of the population and emphasize doing at least moderate physical activity. An important point is that it does not matter what type of physical activity is performed; instead the key factor is total energy expenditure. |
| Gibala & McGee (2008), *Exercise and Sports Sciences Reviews* | 317 | High-intensity interval training (HIT), performed for at least 6 weeks, increases peak oxygen uptake and the maximal activity of mitochondrial enzymes in skeletal muscles. A number of metabolic adaptations usually associated with traditional high-volume endurance training can be induced faster than previously thought with a surprisingly small volume of HIT. |
| Morris & Hardman (1997), *Sports Medicine* | 312 | Walking is the most natural form of physical activity for a large majority of people. Walking in training zone (over 70% of maximum heartrate) has been related to numerous health benefits including muscle strength, posture and carriage, weight loss, improved metabolism of high-density lipoprotein, and insulin/glucose dynamics. |
| Powell et al. (2011), *Annual Review of Public Health* | 262 | This review discussed what type of activity is necessary for health benefits, from the perspective of how much exercise and what intensity of exercise drive such benefits. Aerobic activities maintain the metabolic systems to provide energy and the cardiorespiratory systems to circulate raw materials. Ambulatory and strength training activities maintain the strength and function of our muscles and bones. Balance  training, especially when older, helps to keep us from falling.  A curvilinear reduction in risk occurs for a variety of diseases and conditions across volume of activity, with the steepest gradient at the lowest end of the physical activity scale. Some activity is better than none, and more is better than some.  The authors suggest that light- and moderate intensity activities are important at the lower end (left) of the dose-response curve, where benefits are gained or lost more quickly; vigorous activities become important at the high end (right) of the curve, where changes in relative risk are slower. |
| Vallerand & Losier (1999), *Journal of Applied Sports Psychology* | 251 | Motivation for exercise is crucial in order to understand the consequences of exercise on affective (e.g., mood, satisfaction), cognitive (e.g., concentration, memory), and behavioral (e.g., persistence, performance) outcomes. This narrative review suggests that exercisers with intrinsic motivation (engaging in sports for self-determined reasons), unlike exercisers with extrinsic motivation, are more likely to obtain positive affective, cognitive, and behavioral outcomes when engaging in exercise. |

**TABLE A11**

**REVIEW ARTICLES ON PHYSICAL ACTIVITY INTERVENTIONS**

|  |  |  |
| --- | --- | --- |
| Authors (Year), Journal | Citations | Main Findings |
| Kahn et al. (2002) *American Journal of Preventive Medicine* | 1228 | This systematic review evaluated the effectiveness of various approaches to increasing physical activity: informational, behavioral and social, and environmental and policy approaches. Changes in physical activity behavior and aerobic capacity (VO2 max) were used to assess effectiveness. Two informational interventions (“point-of-decision” prompts to encourage stair use and community-wide campaigns) were effective, as were three behavioral and social interventions (school-based physical education, social support in community settings, and individually-adapted health behavior change) and one environmental and policy intervention (creation of or enhanced access to places for physical activity combined with informational outreach activities). |
| Bravata et al. (2007) *Journal of the American Medical Association* | 1133 | This review of 26 studies concludes that the use of a pedometer is associated with significant increases in physical activity (26.9% over baseline) and significant decreases in body mass index (0.38) and blood pressure (3.8 mmHg). An important predictor of increased physical activity was having a step goal such as 10,000 steps per day. Whether these changes are durable over the long term is undetermined. |
| Pescatello et al. (2004), *Medicine and Science in Sports and Exercise* | 970 | Exercise programs that primarily involve endurance activities prevent the development of hypertension and lower blood pressure in adults with normal BP and those with hypertension. It is recommended to work out on most, preferably all, days of the week for a minimum of 30 minutes of continuous or accumulated physical activity per day at moderate intensity (40-60% of VO2R) and to focus primarily on endurance physical activity supplemented by resistance exercise. |
| Shaw et al. (2006) *Cochrane Database of Systematic Reviews* | 492 | This review of randomized controlled trials concludes that when compared with no treatment, exercise resulted in small weight losses, reductions in diastolic blood pressure, triglycerides, and fasting glucose. Higher intensity exercise resulted in greater weight loss and reductions in fasting glucose. |
| Conn et al. (2009),  *American Journal of Preventive Medicine* | 356 | This meta-analysis evaluated the effectiveness or work-related physical activity programs on various health outcomes. Positive effects of these programs were observed for physical activity behavior (*d* = 0.21); aerobic fitness (*d* = 0.57); lipids (*d* = 0.13); work attendance (*d* = 0.19); and job stress (*d* = 0.33). |
| Lakka & Laaksonen (2007), *Applied Physiology Nutrition and Metabolism* | 232 | This review of randomized controlled trials and epidemiological studies concludes that randomized controlled trials have shown that exercise training has a mild or moderate favorable effect on many metabolic and cardiovascular risk factors (e.g., high BMI, triglycerides, fasting glucose levels, hypertension, and low HDL-C) that constitute or are related to metabolic syndrome (MetS). Epidemiological studies suggest that regular physical activity prevents type 2 diabetes, cardiovascular disease, and premature mortality in large part through the reduction of these risk factors. |
| Foster et al. (2005). *Cochrane Database of Systematic Reviews* | 215 | This review suggests that physical activity interventions have a moderate effect on self-reported physical activity, on achieving a predetermined level of physical activity, and cardio-respiratory fitness. The effect of interventions on self-reported physical activity is positive and moderate (*d* = 0.28) as is the effect of interventions on cardio-respiratory fitness (*d* = 0.52). Cardio-respiratory fitness was either estimated from a sub-maximal fitness test or recorded directly from a maximal fitness test and was expressed as maximal oxygen consumption (VO2 max). |
| Davies et al. (2012), *International Journal of Behavioral Nutrition and Physical Activity* | 213 | This review of randomized control trials evaluated the effectiveness of internet-delivered physical activity behaviour change programs in increasing physical activity. The overall mean effect of internet-delivered interventions on physical activity was d = 0.14. The inclusion of educational components significantly increased intervention effectiveness. Results of the meta-analysis support the delivery of internet-delivered interventions in producing positive changes in physical activity, however effect sizes were small. |
| Prieske et al. (2019), *Sports Medicine* | 0 | This meta-analysis of 19 studies on the effectiveness of workplace physical exercise training (PET) revealed small-sized effects of PET on cardiorespiratory fitness (CRF), muscular endurance, and muscle power (*d*  = 0.29). Medium effects were found for CRF and muscular endurance in younger workers (≤ 45 years) (*d*  = 0.71) and white-collar workers (*d*  = 0.60), respectively. None of the examined training modalities (e.g., training duration, intensity, frequency) predicted the effects of PET on CRF. Significant PET effects on CRF were observed when conducted for 9–12 weeks (*d*  = 0.31) and for 17–20 weeks (*d*  = 0.74). PET effects on physical fitness in healthy workers are moderated by age (CRF) and occupation type (muscular endurance). Further, longer training periods of the PET programs (17 to 20 weeks) have a higher potential to improve CRF in workers. |