Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures

Part 1. Prospective Cohort Studies (n=11)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Nguyen et al., 1996 (1)	Dubbo Osteoporosis Epidemiology Study 820 men 98.6% Caucasian 60+ years	Low-trauma fractures over 5-year follow-up	PA was assessed as hours/day in 5 categories of activity (weighting factors): Basal (1.0) Sedentary (1.1) Light (1.5) Moderate (2.4) Heavy (5.0) Intensity-weighted activities were summed to yield a total PA index (PAI)	**PA index:** PAI=1 1.0 PAI=7 **0.71 (0.55-0.91)**	–
Nguyen et al., 1996 (1)	Dubbo Osteoporosis Epidemiology Study 820 men 98.6% Caucasian 60+ years	Low-trauma fractures over 5-year follow-up	PA was assessed as hours/day in 5 categories of activity (weighting factors): Basal (1.0) Sedentary (1.1) Light (1.5) Moderate (2.4) Heavy (5.0) Intensity-weighted activities were summed to yield a total PA index (PAI)	**PA index:** PAI=1 1.0 PAI=7 0.86 (0.72-1.02)	Femoral neck bone mineral density
Gregg et al., 1998 (2)	Study of Osteoporotic Fractures 9,704 women 65+ years Non-black 7.6 year follow-up for hip, wrist fractures 3.7 year follow-up for spine fractures	Hip, wrist, vertebral fractures	Total PA index (kcal/week), summed from frequency and duration of participation in 33 physical activities in past year, number of city blocks walked per day, flights of stairs climbed per day. Classified by quintiles of PA: Quintile 1 <340 kcal/week Quintile 2 341-737 kcal/week Quintile 3 738-1,289 kcal/week Quintile 4 1,290-2,201 kcal/week Quintile 5 2,201+kcal/week Assessed inactivity as hours/day spent sitting Assessed participation in sport or recreational activity as none, low intensity, or moderate/vigorous intensity Assessed household chores as hours/week doing heavy chores (scrubbing floors, vacuuming, sweeping, yard work, gardening, shoveling snow)	**HIP FRACTURES** **Quintiles of total PA** Quintile 1 1.0 Quintile 2 0.77 (0.58-1.02) Quintile 3 0.78 (0.59-1.04) Quintile 4 **0.64 (0.47-0.88)** Quintile 5 **0.64 (0.45-0.89)** **trend, P = 0.003** **Sport/recreational activity** None 1.0 Low **0.76 (0.61-0.95)** Mod-vig **0.58 (0.43-0.79)** **trend, P = 0.0004**	Age, weight, smoking, estrogen, dietary calcium, falls, alcohol intake, self-rated health, functional difficulty

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Gregg et al., 1998 (2)	Study of Osteoporotic Fractures 9,704 women 65+ years Non-black 7.6 year follow-up for hip, wrist fractures 3.7 year follow-up for spine fractures	Hip, wrist, vertebral fractures	Total PA index (kcal/week), summed from frequency and duration of participation in 33 physical activities in past year, number of city blocks walked per day, flights of stairs climbed per day. Classified by quintiles of PA: Quintile 1 <340 kcal/week Quintile 2 341-737 kcal/week Quintile 3 738-1,289 kcal/week Quintile 4 1,290-2,201 kcal/week Quintile 5 2,201+kcal/week Assessed inactivity as hours/day spent sitting Assessed participation in sport or recreational activity as none, low intensity, or moderate/vigorous intensity Assessed household chores as hours/week doing heavy chores (scrubbing floors, vacuuming, sweeping, yard work, gardening, shoveling snow)	**HIP FRACTURES** **Heavy chores (hours/week)** <5 1.0 5-9 0.93 (0.72-1.20) >9 **0.78 (0.62-0.99)** **trend, P = 0.14** **Time spent sitting (hours/day)** <6 1.0 6-8 0.98 (0.77-1.25) >8 **1.37 (1.08-1.76)** **trend, P = 0.01** **WRIST FRACTURES** No significant associations **VERTEBRAL FRACTURES** Quintiles of total PA Quintile 1 1.0 Quintile 2 0.76 (0.54-1.05) Quintile 3 **0.63 (0.44-0.89)** Quintile 4 0.99 (0.72-1.38) Quintile 5 0.84 (0.59-1.19) **trend, P >0.2** **Sport/recreational activity** None 1.0 Low 0.99 (0.76-1.29) Mod/vig **0.67 (0.49-0.94)** **trend, P = 0.01** **Heavy chores (hours/week)** <5 1.0 5-9 1.04 (0.79-1.38) >9 1.09 (0.85-1.39) **trend, P >0.2** **Time spent sitting (hours/day)** <6 1.0 6-8 1.22 (0.95-1.56) >8 1.09 (0.82-1.44) **trend, P >0.2**	Age, weight, smoking, estrogen, dietary calcium, falls, alcohol intake, self-rated health, functional difficulty

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Joakimsen et al., 1998 (3)	Tromso Study 3,291 women 3,010 men 45+ years	Non-vertebral fractures, 1988 to 1995	PA surveys conducted in 1979-80 and 1986-87 Leisure time PA in previous year, scored as: 1=reading, watching TV, or other sedentary activity 2=walking, cycling, or other forms of exercise at least 4 hours/week 3=participation in recreational activities, heavy gardening 4=participation in hard training or sports competitions several times/week Occupational PA in previous year, scored as: 1=mostly sedentary 2=work requiring a lot of walking 3=work requiring a lot of walking and lifting 4=work requiring heavy manual labor Maximum score=16 (4 in each category, at each survey) Categorized by sex in tertiles of PA (low, medium, high)	**Men, total PA score all fractures** Low 1.0 Medium 0.9 (0.6-1.3) High **0.5 (0.3-0.8)** **Men, fracture in weight-bearing regions** Low 1.0 Medium 1.0 (0.5-1.8) High **0.3 (0.1-0.7)** **Women, total PA score** No significant associations	Age, BMI, height, smoking, and intake of milk, coffee, and alcohol
Kujala et al., 2000 (4)	Finnish Twin Cohort Study 3,167 men 44+ years 21-year follow-up	Hip fractures	Participation in vigorous leisure-time PA (defined as intensity greater than walking) – yes/no	**Participation in vigorous PA:** No 1.0 **Yes** **0.38 (0.16-0.91)**	Age, height, BMI, baseline diseases, smoking, alcohol use, work PA, occupational group
Kujala et al., 2000 (4)	Finnish Twin Cohort Study 3,167 men 44+ years 21-year follow-up	Hip fractures	Categorical leisure-time PA: 1. Sedentary – no leisure PA 2. Occasional exercise – not sedentary, not conditioning exerciser 3. Conditioning exercise – at least 6 days/month for mean duration of 30 minutes with mean intensity equivalent to at least vigorous walking or jogging	**Categorical PA:** Sedentary 1.0 Occasional 0.80 (0.41-1.54) Conditioning 0.41 (0.05-3.30) **trend, P = 0.35**	Age, height, BMI, baseline diseases, smoking, alcohol use, work PA, occupational group

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Kujala et al., 2000 (4)	Finnish Twin Cohort Study 3,167 men 44+ years 21-year follow-up	Hip fractures	MET index quartile, to account for intensity, duration, and frequency of activities: Quartile 1 <0.525 MET-hours/day Quartile 2 0.525-1.525 MET-hours/day Quartile 3 1.525-3.4 MET-hours/day Quartile 4 >3.4 MET-hours/day	**MET index quartiles:** Quartile 1 1.0 **Quartile 2 0.36 (0.15-0.86)** Quartile 3 0.62 (0.29-1.32) Quartile 4 0.81 (0.39-1.66) **trend, P = 0.62**	Age, height, BMI, baseline diseases, smoking, alcohol use, work PA, occupational group
Hoidrup et al., 2001 (5)	Copenhagen Center for Prospective Population Studies 13,183 women 17,045 men 20-93 years	Hip fractures	Leisure-time PA was assessed by having participants place themselves in the following categories: 1 – Sedentary 2 – Moderately active 2-4 hours/week 3 – Moderately or energetically active >4 hours/week PA was assessed at baseline and a follow-up visit. PA change categories were based on scores at both visits: 1-1 2-2 3-1 1-2 2-2 3-2 1-3 2-3 3-3 PA at work was categorized as: Sedentary Standing and walking Walking and lifting Physically exacting work	**Leisure-time PA, women:** Sedentary 1.0 2-4 hours/week **0.72 (0.59-0.89)** >4 hours/week **0.72 (0.57-0.92)** **Leisure-time PA, men:** Sedentary 1.0 2-4 hours/week 0.75 (0.55-1.03) >4 hours/week 0.76 (0.55-1.07)	Age, PA at work, smoking, alcohol intake, BMI, education
Hoidrup et al., 2001 (5)	Copenhagen Center for Prospective Population Studies 13,183 women 17,045 men 20-93 years	Hip fractures	Leisure-time PA was assessed by having participants place themselves in the following categories: 1 – Sedentary 2 – Moderately active 2-4 hours/week 3 – Moderately or energetically active >4 hours/week PA was assessed at baseline and a follow-up visit. PA change categories were based on scores at both visits: 1-1 2-2 3-1 1-2 2-2 3-2 1-3 2-3 3-3 PA at work was categorized as: Sedentary Standing and walking Walking and lifting Physically exacting work	**Change in PA, women+men:** 1-1 1.22 (0.83-1.81) 1-2 1.26 (0.88-1.81) **1-3 1.73 (1.10-2.70)** **2-1 1.53 (1.12-2.08)** 2-2 1.0 2-3 0.97 (0.72-1.30) 3-1 1.61 (0.97-2.76) 3-2 0.98 (0.69-1.38) 3-3 1.16 (0.85-1.58)	Sex, age, PA at work, smoking, alcohol intake, BMI, education

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Feskanich et al., 2002 (6)	Nurses' Health Study 61,200 women approximately 98% white 40-77 years at baseline (1986) 11.6-year follow-up	Hip fractures	MET scoring of PA (MET- hours/week summed across all activities) was assessed at 2-year intervals. At each 2-year follow-up, MET-hours/week scores were the means from all questionnaires up to that time. Scores were derived from time spent in previous year in: Walking, hiking, Jogging, Running, Cycling, Racquet sports, Lap swimming, Other aerobic activities Assessed inactivity as hours/week spent sitting or standing Changes in PA from 1980 to 1986 (before accrual of fracture data) were based on estimated number of hours/week of leisure-time PA.	**MET- hours/week of PA:** <3 1.0 3-8.9 0.79 (0.60-1.03) 9-14.9 **0.67 (0.49-0.92)** 15-23.9 **0.53 (0.37-0.74)** 24+ **0.45 (0.32-0.63** **trend, P <0.001**	MET-hours, BMI, age, smoking, estrogen, and intakes of calcium, vitamin D, retinol, protein, vitamin K, alcohol, and caffeine
Feskanich et al., 2002 (6)	Nurses' Health Study 61,200 women approximately 98% white 40-77 years at baseline (1986) 11.6-year follow-up	Hip fractures	MET scoring of PA (MET- hours/week summed across all activities) was assessed at 2-year intervals. At each 2-year follow-up, MET-hours/week scores were the means from all questionnaires up to that time. Scores were derived from time spent in previous year in: Walking, hiking, Jogging, Running, Cycling, Racquet sports, Lap swimming, Other aerobic activities Assessed inactivity as hours/week spent sitting or standing Changes in PA from 1980 to 1986 (before accrual of fracture data) were based on estimated number of hours/week of leisure-time PA.	**Relative risk for hip fracture was reduced by 6% (4-9%, P <0.001) for each 3 MET- hours/week of PA (about 1 hour walking at moderate pace)** **Time spent walking (hours/week):** <1 1.0 1 0.79 (0.55-1.14) 2-3 0.78 (0.53-1.14) 4+ **0.59 (0.37-0.94)** **trend, P = 0.02** **Walking pace:** Easy 1.0 Average **0.51 (0.37-0.71)** Brisk **0.35 (0.22-0.55)**	BMI, age, smoking, estrogen, and intakes of calcium, vitamin D, retinol, protein, vitamin K, alcohol, and caffeine

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Feskanich et al., 2002 (6)	Nurses' Health Study 61,200 women approximately 98% white 40-77 years at baseline (1986) 11.6-year follow-up	Hip fractures	MET scoring of PA (MET- hours/week summed across all activities) was assessed at 2-year intervals. At each 2-year follow-up, MET-hours/week scores were the means from all questionnaires up to that time. Scores were derived from time spent in previous year in: Walking, hiking, Jogging, Running, Cycling, Racquet sports, Lap swimming, Other aerobic activities Assessed inactivity as hours/week spent sitting or standing Changes in PA from 1980 to 1986 (before accrual of fracture data) were based on estimated number of hours/week of leisure-time PA.	**Time spent sitting (hours/week):** <10 1.0 10-24 0.96 (0.65-1.43) 25-39 1.02 (0.67-1.55) 40-54 0.96 (0.62-1.47) 55+ 1.29 (0.85-1.96) trend, P = 0.16	Sitting, standing, MET-hours, BMI, age, smoking, estrogen, and intakes of calcium, vitamin D, retinol, protein, vitamin K, alcohol, and caffeine
Feskanich et al., 2002 (6)	Nurses' Health Study 61,200 women approximately 98% white 40-77 years at baseline (1986) 11.6-year follow-up	Hip fractures	MET scoring of PA (MET- hours/week summed across all activities) was assessed at 2-year intervals. At each 2-year follow-up, MET-hours/week scores were the means from all questionnaires up to that time. Scores were derived from time spent in previous year in: Walking, hiking, Jogging, Running, Cycling, Racquet sports, Lap swimming, Other aerobic activities Assessed inactivity as hours/week spent sitting or standing Changes in PA from 1980 to 1986 (before accrual of fracture data) were based on estimated number of hours/week of leisure-time PA.	**Time spent standing (hours/week):** <10 1.0 10-24 0.77 (0.55-1.07) 25-39 0.77 (0.55-1.09) **40-54 0.66 (0.45-0.97)** **55+ 0.54 (0.54-0.84)** **trend, P = 0.01** **For those reporting <1 hour/week PA in 1980, PA (hours/week) in 1986:** <1 1.0 1 0.86 (0.52-1.43) 2-3 0.79 (0.45-1.38) 4+ 0.53 (0.27-1.04) **trend, P = 0.07** **For those reporting 4+ hours/week PA in 1980, PA (hours/week) in 1986:** <1 **2.08 (1.20-3.61)** 1 1.47 (0.80-2.71) 2-3 **1.73 (1.02-2.95)** 4+ 1.0 **trend, P = 0.004**	Sitting, standing, MET-hours, BMI, age, smoking, estrogen, and intakes of calcium, vitamin D, retinol, protein, vitamin K, alcohol, and caffeine

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Herala et al., 2002 (7)	Home-dwellers born before 1921, living near Oulu, Finland 148 women 136 men 71+ years Performed heavy outdoor work 1+ day/week at baseline	Fall-related fractures in 2.5 years follow-up	Assessed PA as frequency of heavy outdoor work with the question, "How often do you do heavy outdoor work nowadays?" 1 = never 2 = <1 day/week 3 = 1 day/week 4 = daily Study cohort included those in categories 3 and 4 at baseline and evaluated effect of decreased PA after 2.5 years.	**Absolute fracture incidence:** Maintained PA 5% Decreased PA 15% **P <0.001**	–
Herala et al., 2002 (7)	Home-dwellers born before 1921, living near Oulu, Finland 148 women 136 men 71+ years Performed heavy outdoor work 1+ day/week at baseline	Fall-related fractures in 2.5 years follow-up	Assessed PA as frequency of heavy outdoor work with the question, "How often do you do heavy outdoor work nowadays?" 1 = never 2 = <1 day/week 3 = 1 day/week 4 = daily Study cohort included those in categories 3 and 4 at baseline and evaluated effect of decreased PA after 2.5 years.	**Relative fracture risk:** Maintained PA 1.0 Decreased PA **2.7 (1.14-6.62)**	Sex, age, reaction time, ADL, dependency
Roy et al., 2003 (8)	European Prospective Osteoporosis Study 3,402 women 3,173 men 50-79 years	Vertebral fractures over 3.8 years follow-up	Current daily PA assessed as time typically spend walking or cycling as: None 30 minutes 30-60 minutes >60 minutes Assessed most strenuous level of work and leisure-time PA undertaken on a daily basis at 3 age intervals (15-25 years, 25-50 years, 50+ years) as: Light Moderate Heavy Very heavy	No significant associations of current or past PA with risk for vertebral fractures in women or men	Age, center

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Samelson et al., 2006 (9)	Framingham Study 452 women 252 men 47-72 years	Vertebral fractures over 25-year follow-up	Work and leisure-time PA was assessed in 1956 and 1972 as the average number of hours/day in the following categories: Slight Moderate Heavy Time in each category was multiplied by a weight based on VO_2 for the category. PA was categorized for analyses as tertiles for each sex (low, middle, high).	**Work and leisure-time PA tertile, women:** Low 1.0 Middle 0.82 (0.52-1.30) High 0.61 (0.26-1.44) **Work and leisure-time PA tertile, men:** Low 1.0 Middle 0.44 (0.16-1.18) High 0.53 (0.18-1.64)	Age, height, weight, prevalent vertebral fractures, smoking, alcohol intake
Thorpe et al., 2006 (10)	Adventist Health Study 1,865 women Non-Hispanic whites 45+ years or postmenopausal Average follow-up, 25.2 years	Wrist fractures	4-level index of PA generated from 10 items on work, recreational, and leisure-time PA: 1 – None (no vigorous leisure exercise; work rarely or never includes vigorous PA) 2 – Low (vigorous exercise <15 minutes/day, 3 or more days/week and work infrequently involves vigorous PA, **OR** no vigorous leisure exercise but work involves frequent vigorous PA) 3 – Moderate (regular moderate leisure exercise 15+ minutes/day, 3+days/week and work involves some vigorous PA, **OR s**ome vigorous leisure exercise <15 minutes/day, 3+ days/week, but work involves frequent vigorous PA) 4 – High (regular high-level exercise 15+ minutes/day, 3+ days/week **OR** work involves frequent vigorous PA)	**Occupational and leisure PA index:** Low or none 1.0 Moderate 0.69 (0.44-1.08) **High 0.61 (0.41-.87)** **trend, P = 0.004**	–

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 1. Prospective Cohort Studies (n=11) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Michaelsson et al., 2007 (11)	Uppsala Longitudinal Study of Adult Men 2,205 men 49-51 years at baseline Follow-up at ages: 60, n=1,860 70, n=1,221 77, n=839 82, n=530	Hip fractures Any fractures	PA categories: Low Medium High Categorization based on highest positive response to the questions: 1. Do you spend most of your time reading, watching TV, going to the cinema, or engaging in other, mostly sedentary activities? 2. Do you often go walking or cycling for pleasure? 3. Do you engage in any active recreational sports or heavy gardening for at least 3 hours every week, or do you regularly engage in hard physical training or competitive sport?	**Absolute hip fracture risk:** Low 20.5% Medium 13.3% High 8.4% **Absolute total fracture risk:** Low 43.6% Medium 33.3% High 30.2% **Relative hip fracture risk:** High 1.0 Medium **1.61 (1.10-2.36)** Low **2.65 (1.55-4.24)** **Relative total fracture risk:** High 1.0 Medium 1.14 (0.94-1.38) Low **1.57 (1.20-2.07)**	Change in PA during follow-up; weight, height, smoking, perceived health, PA at work, diabetes mellitus, musculoskeletal disorder, alcohol use

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 2. Retrospective Cohort Studies (n = 1)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Greendale et al., 1995 (12)	Rancho Bernardo Study 1,014 women 689 men Caucasian 50+ years	Osteo-porotic fractures over 19-year interval	Current (previous year) and past (teen-aged years, 30 years, 50 years) PA was at least 3 days/week and 15 minutes/day of exercise categorized as: 1 = Less than mild 2 = Mild 3 = Moderate 4 = Strenuous Maximal lifetime PA score was 16 (sum across 4 age intervals); cohort was divided into tertiles by lifetime PA score	No significant associations of PA at any age with any osteoporotic fracture in women or men	Age, sex, BMI, dietary calcium, alcohol intake, smoking, thiazides, arthritis, estrogen, PA at other age intervals

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 3. Case-Control Studies (n = 6)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Jaglal et al., 1995 (13)	Hip fractures treated at 17 hospitals in Toronto, Canada Women 55-84 years 331 cases 1,002 controls	Hip fractures	Leisure-time PA: Inactive – bottom 20% Active – middle 60% Very active – top 20%	**Leisure-time PA** Inactive 1.0 Very active **0.41 (0.24-0.70)**	Occupational PA
Jaglal et al., 1995 (13)	Hip fractures treated at 17 hospitals in Toronto, Canada Women 55-84 years 331 cases 1,002 controls	Hip fractures	Occupational PA: L1 - >20 years, light or sedentary L2 - 1 to 20 years, any level of activity L3 - >20 years, moderate to heavy activity	**Occupational PA** L1 1.0 L2 0.96 (0.70-1.32) L3 **0.53 (0.30-0.95)**	Age, recent leisure-time PA, estrogen, epilepsy, previous fracture, obesity, education
Silman et al., 1997 (14)	European Vertebral Osteoporosis Study Women 50-79 years 884 cases 6,646 controls Men 50-79 years 809 cases 5,922 controls	Vertebral deformity	Occupational and leisure-time PA graded as: 1 = Light (secretarial, office, or similar work) 2 = Moderate (activities involving standing, walking) 3 = Heavy (activities involving lifting heavy loads) 4 = Very heavy (activities involving continuous heavy work) Scored for age periods: 15-24 years 25-49 years 50+ years Assessed current daily cycling and walking	**Occupational and leisure-time PA Men** **Age 15-24** Light 1.0 Moderate 1.1 (0.8-1.4) Heavy 1.2 (0.9-1.5) Very heavy **1.5 (1.1-2.0)** **Age 25-49** Light 1.0 Moderate 1.1 (0.9-1.5) Heavy 1.3 (1.0-1.7) Very heavy **1.6 (1.1-2.2)** **Age 50+** Light 1.0 Moderate 1.0 (0.8-1.2) Heavy 1.0 (0.7-1.3) Very heavy **1.0 (0.7-1.5)**	Age, BMI, smoking, center, PA at other age intervals

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 3. Case-Control Studies (n = 6) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Silman et al., 1997 (14)	European Vertebral Osteoporosis Study Women 50-79 years 884 cases 6,646 controls Men 50-79 years 809 cases 5,922 controls	Vertebral deformity	Occupational and leisure-time PA graded as: 1 = Light (secretarial, office, or similar work) 2 = Moderate (activities involving standing, walking) 3 = Heavy (activities involving lifting heavy loads) 4 = Very heavy (activities involving continuous heavy work) Scored for age periods: 15-24 years 25-49 years 50+ years Assessed current daily cycling and walking	**Occupational and leisure-time PA Women** No significant associations **Recent walking, cycling activity Men** <30 minutes/day 1.0 >30 minutes/day 0.9 (0.8-1.2) **Women** <30 minutes/day 1.0 >30 minutes/day **0.8 (0.7-1.0)**	Age, BMI, smoking, center, PA at all younger age intervals
Stevens et al., 1997 (15)	Home falls that resulted in hip fracture in Miami Beach, FL Women 368 cases 531 controls Men 103 cases 181 controls 65+ years 98.2% white	Fall-related fractures	Vigorous PA in the month before fall (cases) or before some date (controls) was assessed with the question, "Before [the reference period], did you do exercise, heavy housecleaning, or other hard labor 3 or more times per week?" (yes or no) Mild PA was assessed with the question, "Before [the reference period], about how many hours per day did you spend on your feet?", categorized as: None Up to 1 2-4 5-7 8+ Dependency in ADLs was assessed with the Katz index.	**Vigorous PA:** No 1.0 Yes **0.7 (0.5-0.8)** **Vigorous PA in those with no ADL dependency:** No 1.0 Yes **0.6 (0.4-0.8)** **Vigorous PA in those with any ADL dependency:** No 1.0 Yes **3.2 (1.1-9.8)** **Mild PA:** \No significant associations with fracture risk	Sex, age, mental status, Quetelet Index

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 3. Case-Control Studies (n = 6) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Kanis et al., 1999 (16)	Hip fractures treated at 14 centers in 6 countries in the MEDOS study (France, Greece, Italy, Portugal, Spain, Turkey) Men 50+ years 730 cases 1,132 controls	Hip fractures	Sport and leisure-time PA during: Childhood Young adulthood Recent past (middle age to sampling) Responses at each age scored as 0-4 and summed across ages: 0 = Never 1 = Occasionally 2 = Less than 1 hour/week 3 = 1-2 hours/week 4 = More frequently Categorized by quintiles of PA scores	**Sport and leisure-time PA:** Quintile 1 1.00 Quintile 2 0.85 (0.63-1.15) Quintile 3 **0.67 (0.48-0.95)** Quintile 4 **0.62 (0.45-0.87)** Quintile 5 **0.34 (0.21-0.53)** **trend, P <0.0001**	Age, center
Farahmand et al., 2000 (17)	Hip fracture cases in 6 Swedish counties among women born after 1913 Women 50-81 years 1,327 cases 3,262 controls	Hip fractures	PA was assessed by the question, "Do you or did you ever practice sports or physical exercise during leisure time?" Response options were: Never <1 hour/week 1-2 hours/week >2 hours/week PA information was requested for three life intervals: Before age 18 years At 18-30 years Recent years Recent PA was compared with PA during ages 18-30 years and categorized as: Unchanged low (never or <1 hour/week) Decreased Unchanged moderate Increased Unchanged high	**Recent PA:** None 1.0 <1 hour/week 0.79 (0.62-1.00) 1-2 hours/week **0.67 (0.54-0.84)** 3+ hours/week **0.48 (0.39-0.60)** **trend, P = 0.0001**	BMI, age, PA at other age intervals

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 3. Case-Control Studies (n = 6) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Farahmand et al., 2000 (17)	Hip fracture cases in 6 Swedish counties among women born after 1913 Women 50-81 years 1,327 cases 3,262 controls	Hip fractures	PA was assessed by the question, "Do you or did you ever practice sports or physical exercise during leisure time?" Response options were: Never <1 hour/week 1-2 hours/week >2 hours/week PA information was requested for three life intervals: Before age 18 years At 18-30 years Recent years Recent PA was compared with PA during ages 18-30 years and categorized as: Unchanged low (never or <1 hour/week) Decreased Unchanged moderate Increased Unchanged high	**Changes in PA from age 18-30 years to recent years:** Unchanged low 1.0 Decreased 1.05 (0.84-1.31) Unchanged moderate 1.23 (0.83-1.82) Increased 1.40 (0.90-2.19) Unchanged high 1.05 (0.62-1.78) **trend, P = 0.70**	BMI, age, recent PA
Boonyaratavej et al., 2001 (18)	Hip fractures treated at 14 hospitals in Bangkok, Thailand Chinese, Thai Women 51+ years 229 cases 224 controls	Hip fractures	PA = Housework, occupational, and sport/exercise Level = None, hardly ever, sometimes, very often Past (18-24 years, 25-50 years) and recent (51+ years) All PA summed and grouped by tertiles: Inactive Active Very active	**Recent PA** Inactive 1.0 Active **0.33 (0.19-0.60)** Very active **0.35 (0.18-0.69)** **Past PA** Inactive 1.0 Active 0.67 (0.40-1.12) Very active **0.20 (0.10-0.38)** **trend, P <0.01**	Not clear

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 4. Randomized Controlled Trials, Follow-Up (n = 1)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Sinaki et al., 2002 (19)	50 women who had participated in a 2-year randomized trial of back extension exercise White 58-75 years	Vertebral fractures 8 years after the RCT	Routine weekly PA was total daily PA in homemaking, work, and sports. A PA score was calculated from METs for the activities.	**PA score at 10-year follow-up exercisers > control, P = 0.0106** **Incidence of vertebral fractures:** Exercisers 1.6% Controls 4.3% **P = 0.029**	–

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 5. Cross-Sectional Studies (n = 2)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Ringsberg et al., 2001(20)	Residents of Malmo, Sweden Women, 65-75 years 100 Exercisers 85 Urban controls 53 Rural controls Women, 76-89 years 35 Exercisers 49 Urban controls 35 Rural controls	Total fractures, fragility fractures after age 30 years	Exercisers were women aged 65-89 years who participated regularly in exercise classes 1+ hour/week over previous 20 years Controls were women aged 70 or 80 years randomly selected from urban and rural communities	**Total fractures, 65-75 years:** Urban controls 1.0 Exercisers 0.50 (0.33-0.79) Rural controls 1.0 Exercisers 1.10 (0.63-2.00) **Total fractures, 76-89 years:** Urban controls 1.0 Exercisers 0.28 (0.13-0.56) Rural controls 1.0 Exercisers 0.63 (0.24-1.43) **Total fragility fractures, 65-75 years:** Urban controls 1.0 Exercisers 0.50 (0.27-0.91) Rural controls 1.0 Exercisers 0.66 (0.29-1.43) **Total fragility fractures, 76-89 years:** Urban controls 1.0 Exercisers 0.33 (0.13-0.71) Rural controls 1.0 Exercisers 0.56 (0.19-1.43)	–

Table G5.A1. Studies Reviewed for Evidence That Physical Activity Reduces the Incidence of Osteoporotic Fractures (continued)

Part 5. Cross-Sectional Studies (n = 2) (continued)

Reference	Subjects	Outcome	Physical Activity Exposure	Major Results OR/RR/HR (95% CI) [Note: bold = statistical significance]	Adjusted for
Nordstrom et al., 2005 (21)	Swedish athletes and controls from the national data files Men 60+ years 400 former elite soccer and hockey players 800 controls	Fragility fratures, hip fractures, wrist fractures	Compared the proportion of fractures in former elite athletes and controls	**Total fractures before age 35:** Controls 12.9% Athletes 17.5% *P* <0.05 **Total fractures after age 35:** Controls 12.9% Exercisers 8.5% *P* <0.05 **Fragility fractures after age 50:** Controls 4.2% Athletes 2.0% *P* <0.05 **Wrist fractures after age 50:** Controls 2.5% Athletes 0.7% *P* <0.05 **Hip fractures after age 50:** Controls 1.2% Athletes 0.7% **P = NS**	–

ADL, activities of daily living; BMI, body mass index; CI, confidence interval; HR, hazard ratio; MET, metabolic equivalent task; mod-vig, moderate to vigorous; NS, not significant; OR, odds ratio; PA, physical activity; PAI, physical activity index; OR, odds ratio; RCT, randomized controlled trial; RR, relative risk

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