

## RESEARCH REPORT

# Is housework good for health? Levels of physical activity and factors associated with activity in elderly women. Results from the British Women's Heart and Health Study

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**Objective:** To determine the prevalence of achieving new recommended levels of physical activity, the types of activity involved, and their determinants among elderly British women.

**Design:** National cross sectional survey.

**Participants:** 2341 women aged 60 to 79 from 15 British towns.

**Main outcome measures:** Prevalence of subjects achieving recommended levels of physical activity.

**Results:** Over two thirds of the participants were active at new recommended levels. This was mainly achieved through participation in heavy housework. If domestic activities were excluded only 21% were regularly active. Women who participated in brisk walking for at least 2.5 hours per week had reduced odds of being overweight: odds ratio (95% confidence intervals) 0.5 (0.3 to 0.6) after adjustment for other forms of activity, health status, smoking, and socioeconomic position. Participating in at least 2.5 hours of heavy housework was not associated with reduced odds of being overweight 1.1 (0.8 to 1.4). Age, self reported poor health status, coronary heart disease, and respiratory disease were independently associated with reduced odds of participating in all types of activity. In addition participation in brisk walking and physical exercise were less likely in current smokers, those from the lowest socioeconomic class, and those living in the north of the country. Participation in heavy housework was less likely in women reporting depression but was not associated with smoking, socioeconomic class, or area of residence.

**Conclusions:** If new physical activity recommendations, which include domestic activities, are used to assess population levels of physical activity then it seems that the majority of elderly women are sufficiently active. Heavy housework is not associated with reduced levels of being overweight and prospective studies are necessary to demonstrate an independent health benefit of participating in domestic activities.

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Regular physical activity is associated with increased life expectancy and reduced risk of coronary heart disease, stroke, diabetes hypertension, and obesity.<sup>1–3</sup> Most studies of the benefits of physical activity have been conducted in men and results in women are equivocal. The Framingham Study found that leisure time physical activity was associated with lower levels of all cause mortality and cardiovascular disease mortality in men but not women.<sup>4</sup> Other well conducted cohort studies have found disease associations with physical activity were weaker in women than men.<sup>5–6</sup> In a large cohort study in which 13 375 women and 17 265 men from Denmark were followed up for 14.5 years, leisure time and occupational physical activity were found to be equally protective in women and men.<sup>7</sup> These contradictory results may be attributable to random error associated with the smaller number of events in women, or with measurement error as physical activity assessment tools tend to exclude activities, such as heavy housework, and therefore may be less accurate in women.<sup>7</sup>

Policy on physical activity in both the USA and UK has changed from recommending three episodes of at least 20 minutes of vigorous activity per week, in the light of new evidence demonstrating benefits from less intensive and more sustainable regimens.<sup>1–3 8–11</sup> Policy now encourages regular moderate activity that fits into everyday life—commuter walking and cycling, heavy housework, gardening, and “do it yourself” (home maintenance tasks)—as well as discrete episodes of vigorous activity.<sup>12–14</sup> It is expected that promoting increases in these everyday activities will result in a greater population benefit, particularly for elderly people, as more people will be capable of achieving such recommendations.<sup>9</sup> These moderate

intensity activities will tend to primarily effect energy balance and obesity, though some effect on cardiorespiratory fitness may also be expected,<sup>15–17</sup> and thereby play an important part in reducing the global “obesity epidemic”.<sup>18 19</sup>

Although the evidence regarding the health benefits of moderate activity is robust, studies have largely examined the effects of brisk walking, leisure time exercise, or occupational activity rather than domestic activities.<sup>1–3</sup> Women and elderly people have low reported levels of physical activity,<sup>20 21</sup> but domestic activities may substitute for other types of activity. The aim of this study was to determine the prevalence of levels of different types of physical activity among elderly British women, their association with obesity, and identify the factors that determine physical activity.

## METHODS

### Participants

Data from women who participated in the baseline assessment for the British Women's Heart and Health Study between May 1999 and July 2000 were used. These comprised women aged 60 to 79, selected from the age-sex register of one group general practice in each of 15 towns in England, Wales, and Scotland. The criteria for selecting the town, the general practice and the participants were the same as those used for the British Regional Heart Study.<sup>22</sup> Each woman who attended completed the following: a detailed questionnaire providing information on sociodemographic, lifestyle and health factors; a research nurse-led interview providing more detailed cardiovascular disease information and a drugs history; a physical examination including anthropometric measurements, lung function tests,

**Table 1** Association between different activity types and resting heart rate and body mass index. Elderly British women (n=2341)

Duration	Number	Resting pulse: Mean (SD)	BMI: Mean (SD)	Adjusted* OR (95% CI) being overweight
<i>Vigorous exercise</i>				
0 hours	1948	71.8 (12.8)	27.9 (5.4)	1
0.5–1.0	153	68.9 (9.6)	28.0 (5.3)	1.0 (0.7 to 1.5)
1.5–3.0	148	70.3 (11.1)	27.2 (4.3)	1.1 (0.7 to 1.6)
>3.0	92	67.1 (11.1)	25.7 (3.3)	0.5 (0.3 to 0.8)
		$P_{\text{trend}} < 0.01$	$P_{\text{trend}} < 0.01$	
<i>Brisk walking</i>				
0 hours	1994	71.6 (12.5)	28.2 (5.3)	1
0.5–4.0	145	69.0 (11.6)	26.0 (4.9)	0.5 (0.3 to 0.7)
4.5–8.0	107	71.2 (12.9)	25.1 (3.3)	0.4 (0.2 to 0.6)
>8.0	95	68.5 (11.6)	26.3 (4.3)	0.5 (0.3 to 0.8)
		$P_{\text{trend}} = 0.01$	$P_{\text{trend}} < 0.01$	
<i>Heavy house work</i>				
0 hours	606	71.4 (13.0)	27.9 (5.6)	1
0.5–4.0	909	71.5 (12.4)	27.5 (5.0)	1.1 (0.8 to 1.4)
4.5–8.0	446	71.7 (12.2)	28.2 (5.3)	1.2 (0.9 to 1.7)
>8.0	380	70.2 (12.1)	27.9 (5.2)	1.1 (0.8 to 1.6)
		$P_{\text{trend}} = 0.4$	$P_{\text{trend}} = 0.2$	

\*Adjusted for other activity types, CHD, respiratory disease, arthritis, recent fall, socioeconomic class, smoking, age.

and ECG. In addition general practitioner notes were reviewed and details of major diseases extracted. Full ethics committee approval was obtained for the study.

### Activity levels

Participants were asked to indicate their usual duration of activity in hours per week for several types of activity: walking, cycling, physical exercise (such as fitness classes, aerobics, swimming, jogging, tennis), light and heavy housework, light and heavy gardening and do it yourself (see appendix). In addition they were asked to indicate whether their usual walking pace was slow, steady, brisk, or fast. The questions concerning physical activity were similar to those used in the British Regional Heart Study with the addition in this study of questions on participation in housework, which had not been included in the British Regional Heart Study.<sup>8, 23</sup> Each type of activity was defined as moderate or vigorous based on the US Surgeon General's report on physical activity<sup>12</sup> with brisk or fast walking, cycling, heavy gardening, heavy housework, and do it yourself being categorised as moderate and physical exercise categorised as vigorous. Hours spent on light housework and gardening were not included in the measure.

Recommended levels of activity are 30 minutes of moderate activity on at least five days a week or 20 minutes of vigorous activity three times a week. Women were considered physically active at recommended levels if they engaged in at least 2.5 hours of moderate activity per week or one hour of vigorous activity per week. The small number of women who engaged in both vigorous activity and moderate activity per week were considered active if the total duration exceeded 2.0 hours. In addition, women reported duration of activity throughout the summer and winter. Difference between reported levels of activity in winter and summer were compared with season of completion of baseline assessment to assess possible recall bias.

The effect of different activity types on cardiorespiratory fitness and obesity were assessed by examining the associations between type of activity and resting pulse rate measured as the mean of two readings obtained with the woman seated and relaxed using a Dinamap 1846SX vital signs monitor, and body mass index (BMI, weight in kg/height in metres<sup>2</sup>). Standing height was measured without shoes using a Harpenden Stadiometer, which recorded to the nearest millimetre. Weight was measured in light clothing to the nearest 0.1 kg using Soehnle portable scales.

### Factors associated with activity levels

Participation in specific physical activities according to disease status, smoking, socioeconomic position, and area of residence was examined. Social class was defined by the longest held occupation and classified according to the new government classification.<sup>24</sup> Two measures of social class were separately assessed, one based on the women's longest occupation and the other based on her husband's. Region of residence was defined by whether the town of residence was north or south of a line joining Bristol and the Wash, which divides the more prosperous south east from the more deprived north.<sup>22</sup>

### Statistical analysis

Linear regression was used to assess the association between each activity type and resting pulse after adjustment for the presence of coronary heart disease and age. Multivariate logistic regression was used to assess whether participation in each activity type was associated with reduced odds of being overweight (BMI greater than 25 kg/m<sup>2</sup>) after simultaneous adjustment for participation in any other activity type, poor health status, presence of coronary heart disease, respiratory disease, arthritis, a recent fall, age, and socioeconomic position. Multivariate logistic regression was used to assess the odds of participating in different activities associated with disease status, socioeconomic position and area of residence, each entered as categorical variables as indicated in table 3. These variables were included simultaneously in the model. In multivariate analysis only participants with complete data for all variables were included. The clustered design of the study was assessed in multivariate analyses but did not change results, so all findings are presented unadjusted for town. All analyses were conducted using Stata version 6.<sup>25</sup>

### RESULTS

Of the 4063 invited 2341 (58%) both completed questionnaires and attended the interview and examination. The age and prevalence of general practitioner recorded serious illness (stroke, coronary heart disease, cancer, diabetes) did not differ significantly between those who participated and those who did not. There was no significant difference between activity levels of participants who completed their questionnaire during the spring or summer months (April to September) compared with those who completed it during the rest of the year.

**Table 2** Prevalence of being regularly active at recommended levels of activity and prevalence of regularly engaging in specific activity types. British women aged 60–79 (n=2341)

Physical activity	Number	% (95% CI)
Active at recommended level including domestic activities*	1562	66.7 (64.8 to 68.6)
Regularly active excluding domestic activities†	501	21.4 (19.8 to 23.1)
Brisk walking for at least 2.5 hours per week	279	11.9 (10.6 to 13.3)
Cycling for at least 2.5 hours per week	17	0.7 (0.4 to 1.2)
Heavy gardening for at least 2.5 hours per week	29	1.2 (0.8 to 1.8)
Heavy housework for at least 2.5 hours per week	1241	53.0 (51.0 to 55.0)
Do it yourself for at least 2.5 hours per week	90	3.8 (3.1 to 4.7)
Physical exercise for at least 1 hour per week‡	393	16.4 (15.3 to 18.4)

\*At least 2.5 hours per week of moderate activity (brisk walking, cycling, heavy gardening, heavy housework, DIY) or at least one hour per week of vigorous activity (physical exercise); †at least 2.5 hours per week of moderate activity (brisk walking, cycling) or at least one hour per week of vigorous activity (physical exercise); ‡includes fitness classes, aerobics, swimming, jogging, tennis.

### Association between activity types and cardiorespiratory fitness and obesity.

There were significant trends of decreasing resting pulse and BMI with increasing duration of physical exercise and brisk walking, but no such trends with heavy housework (table 1). After adjustment for age and presence of coronary heart disease physical exercise was associated with a lower heart rate:  $\beta$  (95% confidence intervals) = -0.8 (-1.2 to -0.5) beats per minute per hour of exercise,  $p < 0.01$ . Brisk walking was weakly associated with a lower heart rate, after adjustment for age and heart disease:  $\beta = -0.2$  (-0.3 to -0.1) beats per minute per hour of walking,  $p = 0.03$  and heavy housework was not associated  $\beta = -0.002$  (-0.1 to 0.1)  $p = 0.9$ . After adjustment for other forms of activity and potential confounding factors (table 1) the odds of being overweight were noticeably lower in women who participated in at least 2.5 hours of brisk walking per week and were slightly reduced in those who participated in at least one hour of physical exercise per week but there was no association between heavy housework and being overweight (table 1).

### Levels of activity

Table 2 shows the prevalence of being active and of engaging in different types of activity all year round. Activity levels

during the summer were only slightly higher than during the winter. Over two thirds of participants were active at recommended levels when domestic activities were included in the assessment. When these activities were excluded only 21% were defined as regularly active. Heavy housework was by far the commonest activity undertaken, followed by physical exercise and brisk walking. Very few participants regularly cycled, did heavy gardening or do it yourself.

### Factors associated with participation in different activities

Table 3 summarises the odds of participating in different types of activities for chronic diseases and social factors. Age, self reported poor health status, coronary heart disease, and respiratory disease were associated with reduced odds of participating in all types of physical activity. In addition to these factors, participation in physical exercise was less likely in current smokers, those from socioeconomic group III, and those living in the north. Participation in brisk walking was less likely in those with arthritis, among women who had fallen in the previous 12 months, current smokers, socioeconomic group III, and living in the north. Participation in heavy housework was less likely in women reporting depression, arthritis, and falls, but socioeconomic group and living in the north were not associated with heavy housework.

**Table 3** Odds of regular participation in brisk walking, heavy housework and organised exercise by health status and social factors in British women aged 60–79 (n=2341)

	Number	Adjusted odds ratios* (95% CI)		
		Brisk walking†	Heavy housework‡	Physical exercise‡
Health status, poor	730	0.3 (0.2 to 0.4)	0.5 (0.4 to 0.6)	0.3 (0.2 to 0.4)
CHD	297	0.4 (0.2 to 0.7)	0.7 (0.5 to 0.9)	0.6 (0.4 to 0.9)
Hypertension	523	0.8 (0.5 to 1.1)	1.1 (0.9 to 1.3)	0.9 (0.6 to 1.1)
Cancer	213	1.3 (0.8 to 1.9)	0.7 (0.5 to 0.9)	1.0 (0.7 to 1.6)
Respiratory	558	0.6 (0.5 to 0.9)	0.8 (0.7 to 1.0)	0.8 (0.6 to 1.1)
Arthritis	1020	0.5 (0.4 to 0.7)	0.7 (0.7 to 0.8)	0.9 (0.7 to 1.1)
Falls	386	0.6 (0.4 to 0.9)	0.7 (0.6 to 0.9)	0.9 (0.6 to 1.2)
Depression	400	0.9 (0.7 to 1.3)	0.8 (0.6 to 1.0)	0.9 (0.7 to 1.2)
Smoking, past	710	0.8 (0.6 to 1.0)	0.9 (0.8 to 1.1)	1.1 (0.9 to 1.4)
Smoking, current	265	0.4 (0.2 to 0.7)	1.1 (0.8 to 1.4)	0.5 (0.3 to 0.8)
Age 70–79	1014	0.6 (0.4 to 0.7)	0.7 (0.6 to 0.8)	0.4 (0.3 to 0.5)
SEC woman				
II	640	0.9 (0.6 to 1.3)	1.7 (1.3 to 2.3)	0.8 (0.6 to 1.1)
III	740	0.6 (0.4 to 0.9)	1.7 (1.3 to 2.3)	0.5 (0.4 to 0.8)
SEC husband				
II	310	0.9 (0.6 to 1.3)	0.7 (0.5 to 0.9)	0.6 (0.4 to 0.9)
III	793	0.6 (0.5 to 0.9)	1.3 (0.9 to 1.5)	0.6 (0.5 to 0.8)
Residence, north	1290	0.8 (0.7 to 1.0)	0.9 (0.7 to 1.1)	0.7 (0.6 to 0.9)
Widowed§	584	1.2 (0.9 to 1.8)	1.0 (0.7 to 1.3)	0.9 (0.7 to 1.1)

\*Adjusted for each of the other variables in the table; †2.5 hours per week; ‡1 hour per week; §women who described themselves as divorced or separated (n=96) were not included in this analysis. SEC: British Governments new socioeconomic classification: I – Managerial and Professional Class, II – Intermediate Class, III – Working Class.

## DISCUSSION

Achievement of recommended levels of physical activity depends on the criteria used; inclusion of domestic activities, in particular heavy housework, increases the proportion of elderly women who are active by over threefold. If domestic activities are excluded, then only 21% of this sample of British women aged 60–79 were regularly active. Heavy housework, gardening and “do it yourself” have similar levels of energy expenditure as other moderately intense activities such as brisk walking and it has been argued that people who spend similar amounts of time on either domestic activities or other forms of moderate activity should achieve equal health benefits.<sup>9</sup> A strong and graded response between duration of customary physical activity, comprising predominantly domestic activity, and survival over 10 years has been reported among both men and women over the age of 65 years,<sup>26</sup> suggesting that domestic activities have important health benefits. However, studies examining the health benefits of specific domestic activities have not been published.

Discrete episodes of aerobic activity improve cardiorespiratory fitness (that is, maximal oxygen uptake,  $VO_{2\max}$ ) and have a smaller effect on total energy expenditure, whereas more regular episodes of moderate activity primarily increase energy expenditure and therefore prevent obesity if calorie intake is not increased.<sup>9–17</sup> Regular participation in brisk walking and heavy housework would not be expected to have a major effect on cardiorespiratory fitness but as both expend similar levels of energy they should be equally beneficial in terms of preventing obesity.

Resting heart rate—a marker of cardiorespiratory fitness<sup>16–27–28</sup>—and BMI were associated with both physical exercise and brisk walking as expected.<sup>9–16–17</sup> These findings provide a validation of the brisk walking and physical exercise components of the physical activity assessment used. No relation was seen between heavy housework and resting heart rate or being overweight suggesting that the energy expenditure involved may be less than that involved in brisk walking or physical exercise. It is possible that either recall of time spent in heavy housework is over-estimated or that women who participate in heavy housework to this level simply consume more calories. Further validation of the predictive value of duration of heavy housework will be provided by prospective follow up of the cohort for survival and incident cardiovascular disease.

Walking and leisure time exercise have been found in this and other studies<sup>29</sup> to be associated with higher socioeconomic position and reduced odds of smoking and other adverse life style risk factors. This clustering of behavioural and socioeconomic factors explains some, but not all, of the health benefits of these activities. By contrast, participation in heavy housework is more commonly carried out in lower socioeconomic groups and is not associated with avoidance of smoking. Any potential health benefits from heavy housework may therefore be lost through adverse social circumstances and health behaviours. Wider environmental determinants of participation in physical activity have been reported,<sup>30–31</sup> and it is likely that these may explain both the socioeconomic relations and north-south geographical differences seen. Possible mechanisms include range and quality of local amenities, perceived safety of the environment, and cultural acceptability.

Furthermore, there may be psychological and social pathways through which physical activity improves health. Exercise and activities such as walking are often social experiences, improve psychological wellbeing and social networks, and for some, are an important break from family and work demands.<sup>32</sup> Although being “house-proud” may give some psychological benefit from participation in housework this is unlikely to have the same magnitude of effect as other forms of activity.

## Key points

- Policy recommendations regarding the promotion of physical activity have changed in the past decade with an emphasis now on promoting “active lifestyles”.
- While these recommendations may be achievable by a larger proportion of the population there is very little evidence of a direct health benefit for some of the activities, such as domestic activities, that are recommended in these policies.
- In this study we found that when domestic activities were included in the assessment of levels of physical activity over two thirds of elderly British women were reaching recommended levels of physical activity. This was mainly achieved through participation in heavy housework.
- In cross sectional analysis regular participation in brisk walking, but not heavy housework, was associated with markedly reduced odds of being overweight.
- Among this cohort of elderly women, social and health factors were important determinants of physical activity levels.

Poor health, in particular being diagnosed with coronary heart disease, respiratory disease, arthritis, and having a fall in the previous 12 months were associated with being less active. This cross sectional study cannot determine whether poor health results in decreased activity or poorer health is the result of a lifetime of low activity levels. However, a study of older women drawn from a retired occupational cohort in England found that poor health—particular painful joints and lack of energy—was frequently mentioned as a barrier to activity.<sup>33</sup> Work from the US also suggests that health is a determinant of activity levels.<sup>34</sup> As patients with coronary heart disease may benefit in the long term from regular activity,<sup>35</sup> but increases in activity in the short-term may lead to an increase in symptoms,<sup>36</sup> it is essential that policy on physical activity in older people accommodates both those in good and less good health.

## Study limitations

The response rate, although moderate, was similar to other recent studies in this age group<sup>37</sup> and responders were not significantly different from non-responders in terms of age or general practitioner recorded serious illness suggesting that major selection bias did not occur. Data on the participants usual weekly duration for each activity were collected but it was not possible to examine the intensity with which activities were performed. Duration, rather than intensity, of activity does seem to be of relevance in determining health benefits,<sup>26</sup> and recent evidence suggests that the accumulation of shorter episodes of activity (as little as 15 minutes) is beneficial for cardiovascular health.<sup>38</sup> Validation of physical activity levels using seven day diary methods, while feasible, may not accurately reflect habitual levels of activity that are of greater relevance to reducing cardiovascular disease risk. Where such validation has been attempted moderate agreements have been found.<sup>39–40</sup>

The choice of instrument to measure physical activity was determined by the use of a similar protocol to male participants in the British Regional Heart Study, which shares the same design. Different instruments show moderately strong correlations with each other, so choice of instrument is not a critical issue.<sup>41</sup>

Recall bias may have affected the accuracy of reported levels of activity but there is evidence that people are able to recall habitual activities reasonably well, even over long time periods.<sup>42–43</sup> This form of questioning was used in men in the British Regional Heart Study and shows good predictive validity for all cause and coronary heart disease mortality,<sup>8</sup> suggesting that the approach used provides valid information. In addition there was no seasonal effect on reporting of levels of activity.

**APPENDIX: PHYSICAL ACTIVITY QUESTIONS**

**Physical activity**

Which of the following best describes your usual walking pace?

1       2       3       4  
 Slow      Steady average      Fairly brisk      Fast (at least 4 miles/hr)

In a **typical week** during the past year, how many hours did you spend each week in the following activities? Write 0 if no activity.

Walking to work, shopping and leisure	22.8	Summer _____ hours/week
	22.9	Winter _____ hours/week
Cycling, including to work and leisure	22.10	Summer _____ hours/week
	22.11	Winter _____ hours/week
Gardening, light, for example, pruning, watering	22.12	Summer _____ hours/week
	22.13	Winter _____ hours/week
Gardening, heavy, for example, digging, mowing	22.14	Summer _____ hours/week
	22.15	Winter _____ hours/week
Physical exercise, for example, fitness, aerobics, swimming, jogging, tennis	22.16	Summer _____ hours/week
	22.17	Winter _____ hours/week
DIY, for example, on house, car	22.18	_____ hours/week
Housework activities, light, for example, cooking, washing up, dusting	22.19	_____ hours/week
Housework, heavy, for example, hoovering, floors, window cleaning	22.20	_____ hours/week

In conclusion over two thirds of elderly women in this sample are reaching new recommended levels of physical activity. Heavy housework makes up an important component of activity for this group but may be insufficient in itself to generate health benefits and prospective studies of its health potential are needed. Among older women, social and health factors are important determinants of physical activity levels.

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**Contributors**

All authors took part in the design and supervised data collection for the study. DAL undertook the analysis, DAL wrote the initial draft of

the paper and all authors have contributed to the final version. All authors will act as guarantors.

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**REFERENCES**

- 1 **Andersen LB**, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. *Arch Intern Med* 2000;**160**:1621–28.
- 2 **Sesso HD**, Paffenbarger RSJ, Lee I-M. Physical activity and coronary heart disease in men. The Harvard Alumni Health Study. *Circulation* 2000;**102**:975–80.

- 3 **Berlin JA**, Colditz GA. A meta-analysis of physical activity in the prevention of coronary heart disease. *Am J Epidemiol* 1990;**132**:612–28.
- 4 **Kannel WB**, Sorlie P. Some health benefits of physical activity. The Framingham Study. *Arch Intern Med* 1979;**139**:857–61.
- 5 **Haapanen N**, Miilunpalo S, Vuori I, et al. Association of leisure time physical activity with the risk of coronary heart disease, hypertension and diabetes in middle-aged men and women. *Int J Epidemiol* 1997;**26**:739–47.
- 6 **Mensink GB**, Deketh M, Mul MD, et al. Physical activity and its association with cardiovascular risk factors and mortality. *Epidemiology* 1996;**7**:391–7.
- 7 **Blair SN**, Kohl HW, Barlow CE. Physical activity, physical fitness, and all-cause mortality in women: do women need to be active? *J Am Coll Nutr* 1993;**12**:368–71.
- 8 **Shaper AG**, Wannamethee G, Weatherall R. Physical activity and ischaemic heart disease in middle-aged British men. *Br Heart J* 1991;**66**:384–94.
- 9 **Blair SN**, Kohl HW, Gordon NF, et al. How much physical activity is good for health? *Annu Rev Public Health* 1992;**13**:99–126.
- 10 **Hillsdon M**, Thorogood M, Anstiss T, et al. Randomised controlled trials of physical activity promotion in free living populations: a review. *J Epidemiol Community Health* 1995;**49**:448–53.
- 11 **Hillsdon M**, Thorogood M. A systematic review of physical activity promotion strategies. *Br J Sports Med* 1996;**30**:84–9.
- 12 **United States Department of Health and Human Services**. *Physical activity and health: a report of the surgeon general*. Atlanta, GA: Centers for Disease Control, 1996.
- 13 **Health Education Authority**. *Promoting physical activity in primary care. Guidance for the primary health care team*. London: Health Education Authority, 1996.
- 14 **NHS**. *Our Healthier Nation. National Service Framework for Coronary Heart Disease*. London: The Stationery Office, 2000.
- 15 **Blair SN**, Wei M. Sedentary habits, health, and function in older women and men. *American Journal of Health Promotion* 2000;**15**:1–8.
- 16 **Blair SN**, Jackson AS. Physical fitness and activity as separate heart disease risk factors: a meta-analysis. *Med Sci Sports Exerc* 2001;**33**:762–4.
- 17 **Westertorp KR**. Pattern and intensity of physical activity. *Nature* 2001;**410**:539.
- 18 **World Health Organisation**. *Obesity: preventing and managing the global epidemic. Report of a WHO consultation on obesity*. Geneva: WHO, 1998.
- 19 **Prentice AM**, Jebb SA. Obesity in Britain: gluttony or sloth? *BMJ* 1995;**311**:437–9.
- 20 **Colhoun H**, Prescott-Clarke P, Dong W, et al. *Health Survey for England 1994. Volume 1: Findings*. London: HMSO, 1996.
- 21 **Jones DA**, Ainsworth BE, Croft JB, et al. Moderate leisure-time physical activity: who is meeting the public health recommendations? A national cross-sectional study. *Arch Fam Med* 1998;**7**:285–9.
- 22 **Shaper AG**, Pocock SJ, Walker M, et al. British Regional Heart Study: cardiovascular risk factors in middle-aged men in 24 towns. *BMJ Clin Res Ed* 1981;**283**:179–86.
- 23 **Wannamethee G**, Shaper AG. Physical activity and stroke in British middle aged men. *BMJ* 1992;**304**:597–601.
- 24 **Rose D**, O'Reilly K. *The ESRC review of government social classification*. London: Office for National Statistics, 1998.
- 25 **Stata Corporation**. *Intercooled Stata 6.0 for Windows*. (Version 6.0). Texas: Stata, 1999.
- 26 **Morgan K**, Clarke D. Customary physical activity and survival in later life: a study in Nottingham, UK. *J Epidemiol Community Health* 1997;**51**:490–3.
- 27 **Wannamethee G**, Shaper AG, Macfarlane PW. Heart rate, physical activity, and mortality from cancer and other noncardiovascular diseases. *Am J Epidemiol* 1993;**137**:735–48.
- 28 **Shaper AG**, Wannamethee G, Macfarlane PW, et al. Heart rate, ischaemic heart disease, and sudden cardiac death in middle-aged British men. *Br Heart J* 1993;**70**:49–55.
- 29 **Salmon J**, Owen N, Bauman A, et al. Leisure-time, occupational, and household physical activity among professional, skilled, and less-skilled workers and homemakers. *Prev Med* 2000;**30**:191–9.
- 30 **Sallis JF**, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. *Am J Prev Med* 1998;**15**:379–97.
- 31 **Bauman A**, Smith B, Stoker L, et al. Geographical influences upon physical activity participation: evidence of a “coastal effect”. *Aust N Z J Public Health* 1999;**23**:322–4.
- 32 **Biddle SJH**, Fox KR, Boutcher SH. *Physical activity and psychological well-being*. London: Routledge, 2000.
- 33 **Ebrahim S**, Rowland L. Towards a new strategy for health promotion for older women: determinants of physical activity. *Psychol Health Med* 1996;**1**:29–40.
- 34 **Dishman RK**, Sallis JF, Orenstein DR. The determinants of physical activity and exercise. *Public Health Rep* 1985;**100**:158–71.
- 35 **Jolliffe JA**, Rees K, Taylor RS, et al. Exercise-based rehabilitation for coronary heart disease (Cochrane Review). *Cochrane Database Syst Rev* 2001;**1**:CD001800
- 36 **Ebrahim S**, Williams J. Assessing the effects of a health promotion programme for elderly people. *J Public Health Med* 1992;**14**:199–205.
- 37 **Shah S**, Harris TJ, Rink E, et al. Do income questions and seeking consent to link medical records reduce survey response rates? A randomised controlled trial among older people. *Br J Gen Pract* 2001;**51**:223–5.
- 38 **Lee IM**, Sesso HD, Paffenbarger RSJ. Physical activity and coronary heart disease risk in men. Does the duration of exercise episodes predict risk? *Circulation* 2000;**102**:981–6.
- 39 **Arroll B**, Jackson R, Beaglehole R. Validation of a three-month physical activity recall questionnaire with a seven-day food intake and physical activity diary. *Epidemiology* 1991;**2**:296–9.
- 40 **Blair SN**, Dowda M, Pate RR, et al. Reliability of long-term recall of participation in physical activity by middle-aged men and women. *Am J Epidemiol* 1991;**133**:266–75.
- 41 **Albanes D**, Conway JM, Taylor PR, et al. Validation and comparison of eight physical activity questionnaires. *Epidemiology* 1990;**1**:65–71.
- 42 **Friedenreich CM**, Courneya KS, Bryant HE. The lifetime total physical activity questionnaire: development and reliability. *Med Sci Sports Exerc* 1998;**30**:266–74.
- 43 **Falkner KL**, Trevisan M, McCann SE. Reliability of recall of physical activity in the distant past. *Am J Epidemiol* 1999;**150**:195–205.