Locomotor disability in a cohort of British men: the impact of lifestyle and disease

Shah Ebrahim,a S Goya Wannamethee,b Peter Whincup,b Mary Walkerb and A Gerald Shaperb

Background Increasing life expectancy has brought public health concern about the increase in prevalence of disability in old age. Reducing the prevalence of disability in older age requires the identification of preventable or modifiable risk factors earlier in life. We have examined the relationship between lifestyle and other potential risk factors in men aged 40–59 years at screening and locomotor disability 12–14 years later to assess whether any of these factors have direct and independent roles in influencing disability in later life.

Methods In 1978–1980, a longitudinal study of cardiovascular disease was initiated in 7735 men aged 40–59 years drawn from one general practice in each of 24 British towns. The present study concerns 5717 men, 88% of the surviving men who were available to follow-up (i.e. were registered with a GP and had an address) and who satisfactorily completed the disability section of a follow-up postal questionnaire in 1992 (Q92). The main endpoint from the questionnaire was locomotor disability based on self-reported inability in any one or more of the following: to get outdoors, walk 400 m, climb stairs, maintain balance, bend down, or straighten up.

Results In the 5717 men (mean age 63 years) who provided information on disability status, 25.0% reported locomotor disability and the majority of these men recalled a doctor-diagnosed disease of which cardiovascular disease was most strongly associated with locomotor disability. Lifestyle factors at screening (smoking, physical inactivity, obesity and heavy drinking) and manual social class were strongly and independently associated with increased odds of locomotor disability 12–14 years later. By contrast, baseline blood pressure and serum total cholesterol showed little relationship with locomotor disability. Among men with diagnosed major cardiovascular disease (stroke, myocardial infarction, angina or aortic aneurysm) those with locomotor disability showed significantly higher adverse lifestyle factors at screening than those who were able. Similarly, adverse lifestyle factors were also seen more frequently among disabled men with respiratory disease and among disabled men with other non-cardiovascular conditions than among their able counterparts.

Conclusions Smoking, obesity, physical inactivity and heavy drinking in middle age are strong predictors of locomotor disability in later life independent of the presence of diagnosed disease. Leading a healthy lifestyle improves survival and reduces the incidence of disease. It also reduces the risk of locomotor disability and increases the odds of being disability-free even in the event of developing major cardiovascular disease.

Keywords Locomotor disability, life style, risk factors, cardiovascular disease

Accepted 5 January 2000

© International Epidemiological Association 2000 Printed in Great Britain
Increased life expectancy in the recent decade has aroused public health concern about the growing prevalence of disability in old age. Physical disability in older people affects their quality of life and the need for care and is thus a critically important public health issue. Locomotor disability stands out as the most important single physical disability because of its dramatic effects on the activities of daily life, and it is the most common form of disability in the community. Worldwide, cardiovascular disease is the leading cause of disability and death in older people. Delaying the onset of cardiovascular and other chronic diseases will reduce the time spent living with disability and this concept is the central mechanism of the ‘compression of morbidity’ hypothesis and a means by which healthy active life expectancy may be increased.

Hereditary factors, lifestyle habits, living conditions and environmental factors are all of importance in the development of disease and these factors may also play a role in the onset of disability, even in the presence of established chronic disease. A healthy lifestyle is associated not only with longevity but also improved mobility and independence and less disability in later life. In longitudinal studies of predictors of disability, not all studies have clarified whether risk factors operate directly or whether they predict disability simply through their association with chronic disease. There is evidence suggesting that smoking, body mass index and physical activity are predictive of mobility and physical functioning even when specific chronic diseases have been taken into account. This paper examines the relationship between lifestyle and other risk factors measured in middle age and the reporting of locomotor disability 12–14 years later in order to assess whether these factors have a direct role in influencing locomotor mobility in later life.

Subjects and Methods
The British Regional Heart Study (BRHS) is a prospective study of cardiovascular disease involving 7735 men aged 40–59 years selected from the age-sex registers of one group general practice in each of 24 towns in England, Wales and Scotland. In each town a general practice with a social class distribution representative of that in the town was selected. An overall response rate of 78% was achieved. No attempt was made to exclude those with cardiovascular or other disease or those receiving treatment or medication. Only those men who were unable to participate because of severe mental or physical handicap were excluded from the study (6–10 men per practice). The criteria for selecting the town, the general practice and the subjects as well as the methods of data collection have been reported previously. In 1978–1980 research nurses administered to each man a standard questionnaire that included questions on smoking habits, alcohol intake, physical activity and medical history (Q1). Several physical measurements were made, and blood samples (non-fasting) were taken for measurement of biochemical and haematological variables.

Follow-up
Mortality and morbidity
All men were followed up for all-cause mortality and cardiovascular morbidity. Information on death was collected through the established ‘tagging’ procedures provided by the NHS registers in Southport (for England and Wales) and Edinburgh (for Scotland). Classification into deaths from cardiovascular and non-cardiovascular causes was based on the International Classification of Diseases Ninth Revision codings on the death certificates. Information on non-fatal myocardial infarction and non-fatal strokes were obtained from follow-up reports provided by general practitioners (GPs) supplemented by regular biennial reviews of the patient’s GP records which included correspondence with hospitals and clinics. A non-fatal myocardial infarction was diagnosed according to WHO criteria.

Questionnaire at Q92
In 1992, 12–14 years after screening, a similar but more comprehensive questionnaire (Q92) was posted to 6528 participants who were still alive and in Great Britain. In addition to questions on lifestyle behaviour, current illness and medication, information was collected on locomotor disability. Of the 6528 surviving and available participants, 5934 (91%) completed the Q92 questionnaire. This report is restricted to the 5717 men, now aged 52–73 years (mean 63 years) and comprising 77% of the original 7735 men, who survived to Q92 and who satisfactorily completed the disability section of the questionnaire. There were 217 men who provided inadequate disability information.

Prevalence of disease at Q92
At Q92 the men were asked to recall whether they had ever been told by a doctor that they had any of 13 specified conditions listed on the questionnaire: ischaemic heart disease (angina, heart attack, coronary thrombosis or myocardial infarction), ‘other heart trouble’, high blood pressure, stroke, gout, diabetes, gall bladder disease, thyroid disease, arthritis, bronchitis, asthma, peptic ulcer and cancer.

Disease status
Major cardiovascular disease
Men with major cardiovascular disease at Q92 included those who recalled a doctor diagnosis of myocardial infarction, angina, aortic aneurysm and stroke on Q92 or who had a general practice medical record of a non-fatal cardiovascular event (myocardial infarction or stroke).

Other diseases
This included men who at Q92 recalled a doctor diagnosis of ‘other heart trouble’, high blood pressure, gout, diabetes, gall bladder disease, thyroid disease, arthritis, bronchitis, asthma, peptic ulcer and cancer.

Chest pain on exertion
The WHO (Rose) chest pain questionnaire for angina or possible myocardial infarction was completed at Q92.

Locomotor disability
The men were asked at Q92 whether they currently had difficulty carrying out any of the six following activities on their own as a result of a long-term health problem: (1) going up or down stairs; (2) bending down; (3) straightening up; (4) keeping your balance; (5) going out of the house; (6) walking 400 yards. Men who responded positively to any of these questions were described as having locomotor disability. Men who did not provide information on disability (n = 217) were excluded from the analyses.
Cardiovascular risk factors at baseline

Social class. The longest held occupation of each man was recorded at screening and grouped into one of the six social classes defined by the Registrar General’s occupational classification: I Professional (579 men; 8%), II Managerial (1661 men; 22.9%), III non-manual/clerical (682 men; 9.4%), III manual (3110 men; 42.8%), IV semi-skilled manual (719 men; 9.9%) and V unskilled manual (296 men; 4.1%). Those whose longest held occupation was in the Armed Forces (215 men; 3.0%) form a separate group. Manual social class consisted of group III manual, IV and V.

Smoking. The men were classified as those who had never smoked cigarettes, ex-cigarette smokers and current cigarette smokers.

Alcohol intake. The men were classified into five groups based on estimated weekly alcohol intake at baseline: none, occasional, light, moderate and heavy. Heavy drinking is defined as drinking >6 units (1 UK unit = 8-10 g alcohol) daily or on most days in the week.

Body mass index (BMI). Body mass index (weight/height²) was calculated (kg/m²) for each man based on their measured weight and height. Obesity was defined as BMI ≥28 kg/m², representing the top fifth of the BMI distribution in all men.

Physical activity. At screening the men were asked to indicate their usual pattern of physical activity, which included regular walking or cycling, recreational activity and sporting activity. A physical activity score was derived for each man based on frequency and type of activity and the men were grouped into six broad categories based on their total score: none, occasional, light, moderate, moderately-vigorous and vigorous. Men who were at least moderately active were classified as being physically active.

Systolic blood pressure. The London School of Hygiene sphygmomanometer was used to measure blood pressure twice in succession with the subjects seated and with the arm supported on a cushion. The mean of the two readings was used in the analysis and all blood pressure readings were adjusted for observer variation within each town.

Serum cholesterol. All the blood samples were obtained in the non-fasting state between 0830 and 1830 h. Serum cholesterol was measured by a modified Liebermann-Burchard method on a Technicon SMA 12/60 analyser.

Statistical methods

The relation between cardiovascular risk factors and reporting of disability at Q92 (12–14 years after screening) was assessed by logistic regression, adjusting for the other risk factors. In the adjustment in Table 2 smoking (six levels), physical activity (six levels), alcohol intake (five levels) and social class (seven levels) were fitted as categorical variables; age and BMI were fitted continuously. In Tables 4, 5 and 6 dichotomous variables were used to assess the adjusted relative odds (RO) of having the adverse lifestyle characteristics e.g. current smoking (yes/no), manual social class (yes/no), physically active (yes/no), obese (yes/no) and heavy drinking (yes/no). In Table 3 the men were divided into fifths based on the total distribution of the original 7735 men for serum total cholesterol and systolic blood pressure.

Results

Table 1 shows the prevalence of locomotor problems. One-quarter of the 5717 men (n = 1429) reported some locomotor problem and were classified as having locomotor disability. Of those with disability, 89% recalled a doctor diagnosis of disease and 35% recalled a doctor diagnosis of a major cardiovascular disease (myocardial infarction, angina, stroke or aortic aneurysm). The men were also asked to give details of the condition which caused their locomotor difficulties: they reported cardiovascular conditions (10.2%), respiratory (1.7%), nervous system (2.7%), and musculoskeletal related problems (35.4%), mental illness (1.1%), diabetes (1.1%), poor sight (0.4%), hearing problems (4.2%) and in a proportion the cause was given as not known (33.2%). The percentage of men reporting locomotor disability increased progressively with increasing number of reported conditions from 8.9% in those reporting none to 52.7% in those with three or more conditions. Major cardiovascular diseases and arthritis were most strongly associated with the reporting of locomotor disability (Figure 1). If all men who had a doctor diagnosis of arthritis or who reported musculoskeletal, mental illness, or hearing and vision problems as the cause of their disability are excluded from the data in Figure 1, major cardiovascular disease (stroke, angina, aortic aneurysm and myocardial infarction) still remains the condition most strongly associated with reporting of locomotor disability. Locomotor

<table>
<thead>
<tr>
<th>Problems</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going up or down stairs</td>
<td>761</td>
<td>13.3</td>
</tr>
<tr>
<td>Bending down</td>
<td>883</td>
<td>15.4</td>
</tr>
<tr>
<td>Straightening up</td>
<td>691</td>
<td>12.1</td>
</tr>
<tr>
<td>Keeping your balance</td>
<td>411</td>
<td>7.2</td>
</tr>
<tr>
<td>Going out of the house</td>
<td>200</td>
<td>3.5</td>
</tr>
<tr>
<td>Walking 400 yards</td>
<td>584</td>
<td>10.2</td>
</tr>
<tr>
<td>Any of the above</td>
<td>1429</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Figure 1 Percentage reporting of locomotor disability according to recall of doctor-diagnosed diseases

MI = Myocardial infarction; HBP = High blood pressure.
disability prevalence ranged from 49% in those with stroke to 37% in those with MI. Similarly if those men with major cardiovascular diseases, respiratory, mental and hearing and vision problems as causes of disability were excluded from those reporting arthritis or musculoskeletal problems, the prevalence of disability was 40%. Among those with none of the above diagnoses or reported problems only 4% reported some form of disability.

Cardiovascular risk factors and locomotor disability

The percentage of men reporting locomotor disability increased progressively with increasing age from 18.8%, 22.8%, 28.4% to 31.0% in the four age groups at baseline (40–44, 45–49, 50–54, 55–59). Table 2 shows the locomotor disability rate (%) by baseline characteristics. Social class, smoking, obesity, physical inactivity and heavy drinking were all significantly associated with the odds of reporting locomotor disability even after adjustment for age (Table 2, A). The relationship persisted after further adjustment for each of the other factors (Table 2, B).

Exclusion of 1863 men who reported major cardiovascular disease, respiratory diseases or arthritis at baseline made only minor differences to the pattern of relationships seen (Table 2, C). By contrast with other risk factors, blood pressure and serum total cholesterol at baseline showed no relationship with locomotor disability 12–14 years later after adjustment (Table 3).

Disease status at Q92, locomotor disability and cardiovascular risk factors

To assess whether the relationship seen between lifestyle factors and locomotor disability is simply due to the known association between these factors and the development of disease we separated the men into six groups on the basis of their disease status and disability status at Q92: (1) no disease and able; (2) no disease but disabled; (3) other disease and able; (4) other disease and disabled; (5) major cardiovascular disease (heart attack, stroke, angina or aortic aneurysm) and able (6) major cardiovascular disease and disabled. Note that men who had both major cardiovascular disease and ‘other diseases’ (e.g. other

Table 2  Lifestyle factors at baseline and percentage locomotor disability 12–14 years later and adjusted relative odds

<table>
<thead>
<tr>
<th>Social class</th>
<th>% disabled</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (487)</td>
<td>12.3</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>II (1421)</td>
<td>19.2</td>
<td>1.6 (1.2–2.1)</td>
<td>1.3 (1.0–1.8)</td>
<td>1.1</td>
</tr>
<tr>
<td>IIINM (553)</td>
<td>21.5</td>
<td>1.8 (1.3–2.5)</td>
<td>1.4 (1.0–2.0)</td>
<td>1.2</td>
</tr>
<tr>
<td>IIIM (2343)</td>
<td>28.5</td>
<td>2.7 (2.0–3.5)</td>
<td>1.8 (1.4–2.4)</td>
<td>1.4</td>
</tr>
<tr>
<td>IV (546)</td>
<td>33.7</td>
<td>3.4 (2.5–4.7)</td>
<td>2.2 (1.6–3.1)</td>
<td>1.9</td>
</tr>
<tr>
<td>V (192)</td>
<td>40.1</td>
<td>4.7 (3.1–6.9)</td>
<td>2.9 (1.9–4.4)</td>
<td>2.5</td>
</tr>
<tr>
<td>Armed Forces (164)</td>
<td>27.4</td>
<td>2.5 (1.6–5.0)</td>
<td>1.5 (1.0–2.4)</td>
<td>1.4</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never (1512)</td>
<td>17.1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Ex (2089)</td>
<td>23.3</td>
<td>1.4 (1.2–1.6)</td>
<td>1.2 (1.0–1.5)</td>
<td>1.2</td>
</tr>
<tr>
<td>1–19/day (2107)</td>
<td>30.6</td>
<td>2.0 (1.7–2.5)</td>
<td>1.8 (1.5–2.3)</td>
<td>1.8</td>
</tr>
<tr>
<td>20+/day (1346)</td>
<td>33.6</td>
<td>2.4 (2.0–2.9)</td>
<td>2.0 (1.6–2.4)</td>
<td>1.9</td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (671)</td>
<td>23.4</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2 (1152)</td>
<td>19.3</td>
<td>0.8 (0.6–1.0)</td>
<td>0.9 (0.7–1.2)</td>
<td>0.8</td>
</tr>
<tr>
<td>3 (1622)</td>
<td>22.9</td>
<td>1.0 (0.8–1.2)</td>
<td>1.1 (0.9–1.4)</td>
<td>0.9</td>
</tr>
<tr>
<td>4 (1225)</td>
<td>25.6</td>
<td>1.1 (0.9–1.4)</td>
<td>1.2 (1.0–1.5)</td>
<td>1.1</td>
</tr>
<tr>
<td>5 (1046)</td>
<td>34.8</td>
<td>1.7 (1.4–2.1)</td>
<td>1.8 (1.4–2.3)</td>
<td>1.6</td>
</tr>
<tr>
<td>Physical activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inactive (443)</td>
<td>40.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Occasional (1646)</td>
<td>29.0</td>
<td>0.6 (0.5–0.7)</td>
<td>0.7 (0.5–0.8)</td>
<td>0.7</td>
</tr>
<tr>
<td>Light (1283)</td>
<td>27.1</td>
<td>0.5 (0.4–0.7)</td>
<td>0.6 (0.5–0.8)</td>
<td>0.7</td>
</tr>
<tr>
<td>Moderate (924)</td>
<td>19.1</td>
<td>0.4 (0.3–0.5)</td>
<td>0.4 (0.3–0.6)</td>
<td>0.5</td>
</tr>
<tr>
<td>Moderately-vigorous/vigorous (1344)</td>
<td>16.7</td>
<td>0.3 (0.2–0.4)</td>
<td>0.4 (0.3–0.5)</td>
<td>0.5</td>
</tr>
<tr>
<td>Alcohol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (307)</td>
<td>31.3</td>
<td>1.4 (1.1–1.8)</td>
<td>1.4 (1.0–1.8)</td>
<td>1.3</td>
</tr>
<tr>
<td>Occasional (1382)</td>
<td>23.9</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Light (1974)</td>
<td>19.6</td>
<td>0.8 (0.6–0.9)</td>
<td>0.9 (0.7–1.0)</td>
<td>0.9</td>
</tr>
<tr>
<td>Heavy (591)</td>
<td>34.0</td>
<td>1.7 (1.4–2.1)</td>
<td>1.3 (1.1–1.7)</td>
<td>1.1</td>
</tr>
</tbody>
</table>

A = age-adjusted.
B = adjusted for age and each of the other factors in the Table.
C = adjusted for B and excluding 1863 men with major cardiovascular, respiratory diseases or arthritis.
heart trouble; arthritis) were included in the major cardiovascular groups (5 or 6). Thus the six groups are mutually exclusive. Table 4 shows the characteristics of these groups. Both disabled and able men with major cardiovascular disease showed higher prevalence of risk factors than men free of disease but those who were disabled had more adverse risk factors than those who were able, irrespective of the type of disease. Disabled men were more likely to be manual workers, current smokers, obese, heavy drinkers and less physically active than those who were able. Men with major cardiovascular disease, whether disabled or not, showed the highest mean level of systolic blood pressure and serum total cholesterol but there was little difference between the disabled and able groups. Table 5 compares the adjusted RO of having the adverse lifestyle risk factors between each of the disease/disability categories with disease-free, disability-free men as the reference group with an RO of 1.0. Adjustment of the RO for each of the other lifestyle factors (smoking, social class, obesity, physical activity and heavy drinking) was made. Adverse risk factors were more common in those men with disease and disability and these relationships persisted even after the adjustment.

We also examined the adjusted RO of having adverse lifestyle characteristics in those who are disabled compared to those who are classified as able within disease groups reported at Q92 (Table 6). Respiratory disease (bronchitis and asthma) was separated from the rest of ‘other disease’. This analysis, which allows for the effects of disease status, showed that within each disease group, men with disability were much more likely to have adverse risk factors than men without disability, and the strength of these associations were broadly similar irrespective of the disease suffered. When men who reported arthritis and other musculoskeletal problems, mental illness, and problems with sight or hearing were excluded from these analyses, the pattern observed remained the same—among men with cardiovascular diseases, those reporting locomotor disability were more likely to be manual workers, smokers and heavy drinkers.

Table 3 Locomotor disability (percentage and adjusted odds ratios) at Q92 according to quintiles of systolic blood pressure and serum total cholesterol at screening 12–14 years previously

<table>
<thead>
<tr>
<th>Systolic blood pressure (mmHg)</th>
<th>% disabled</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;128 (1235)</td>
<td>22.3</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>128– (1139)</td>
<td>23.6</td>
<td>1.1 (0.9–1.3)</td>
<td>1.0</td>
</tr>
<tr>
<td>138– (1185)</td>
<td>23.2</td>
<td>1.0 (0.8–1.2)</td>
<td>0.9</td>
</tr>
<tr>
<td>148– (1084)</td>
<td>26.4</td>
<td>1.2 (1.0–1.4)</td>
<td>0.9</td>
</tr>
<tr>
<td>161– (1069)</td>
<td>30.0</td>
<td>1.3 (1.1–1.6)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cholesterol (mmol/l)</th>
<th>% disabled</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5.5 (1188)</td>
<td>25.3</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>5.5– (1011)</td>
<td>23.2</td>
<td>0.9 (0.7–1.1)</td>
<td>0.9</td>
</tr>
<tr>
<td>6.0– (1108)</td>
<td>24.9</td>
<td>1.0 (0.8–1.2)</td>
<td>1.0</td>
</tr>
<tr>
<td>6.5– (1263)</td>
<td>26.3</td>
<td>1.0 (0.9–1.2)</td>
<td>1.0</td>
</tr>
<tr>
<td>7.2– (1118)</td>
<td>25.0</td>
<td>1.0 (0.8–1.2)</td>
<td>1.1</td>
</tr>
</tbody>
</table>

A = age-adjusted.
B = adjusted for age and each of the other factors in Table 2.

Table 4 Disease and locomotor disability status at follow-up at Q92 12–14 years after screening and characteristics at baseline

<table>
<thead>
<tr>
<th>Disease status</th>
<th>No disease</th>
<th>Major cardiovascular disease</th>
<th>Other diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability status</td>
<td>(1602)</td>
<td>(154)</td>
<td>(566)</td>
</tr>
<tr>
<td>Baseline characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (mean)</td>
<td>48.5</td>
<td>49.2</td>
<td>51.6</td>
</tr>
<tr>
<td>% 55–59 years</td>
<td>17.8</td>
<td>23.4</td>
<td>31.1</td>
</tr>
<tr>
<td>% manual occupation</td>
<td>52.1</td>
<td>54.1</td>
<td>51.7</td>
</tr>
<tr>
<td>% never smoker</td>
<td>33.1</td>
<td>22.1</td>
<td>19.7</td>
</tr>
<tr>
<td>% current smoker</td>
<td>31.9</td>
<td>44.2</td>
<td>38.3</td>
</tr>
<tr>
<td>% obese (BMIc ≥28 kg/m²)</td>
<td>12.6</td>
<td>18.2</td>
<td>21.9</td>
</tr>
<tr>
<td>% physically active</td>
<td>47.1</td>
<td>39.3</td>
<td>38.6</td>
</tr>
<tr>
<td>% heavy drinkers</td>
<td>7.7</td>
<td>11.7</td>
<td>8.7</td>
</tr>
<tr>
<td>Mean SBPd (mmHg)</td>
<td>138.3</td>
<td>139.5</td>
<td>148.5</td>
</tr>
<tr>
<td>Mean cholesterol (mmol/l)</td>
<td>6.24</td>
<td>6.29</td>
<td>6.63</td>
</tr>
</tbody>
</table>

a Disability free.
b Locomotor disability.
c Body mass index.
d Systolic blood pressure.
were more likely to be manual workers (adjusted RO = 1.5, 95% CI: 1.1–7.9) than those who were able and
of the presence or absence of diagnosed cardiovascular disease
Lifestyle characteristics measured 12–14 years earlier at 40–59
years and is strongly associated with chronic diseases, in par-
ticular cardiovascular disease and musculoskeletal problems.
Lifestyle characteristics measured 12–14 years earlier at 40–59
years were associated with locomotor disability, independently
of the presence or absence of diagnosed cardiovascular disease
and self-reporting of angina symptoms. Blood pressure and
serum total cholesterol were not associated with locomotor
disability despite their causal relationships with cardiovascular
disease.\textsuperscript{18,19} These relationships were found in those with and
without any diagnosed chronic diseases at baseline. Our find-
ings suggest not only that modification of lifestyle factors may
prevent disability but also that the mechanisms that explain the
relationships between lifestyle factors and disability do not
necessarily operate directly by increasing the risk of cardio-
vascular disease.

Much research on the causes of disability in older people has
focused on the effects of chronic diseases and less attention has
been given to lifestyle and other factors.\textsuperscript{20} In a recent American
study,\textsuperscript{9} weaker associations of lifestyle factors and disability
(current smoking odds ratio 1.2–1.3; heavy drinking 1.0–1.2;
obesity 1.2–1.4; physical inactivity 1.7) independent of chronic
diseases have been reported than in our study. The stronger
associations for these risk factors in the present study may be
explained by differences in definitions of locomotor disability; we
defined a group of men who reported any one of a range of
disabilities, whereas the American criteria define only less severe
locomotor disability. Of the specific lifestyle factors, obesity
appears to be consistently associated with disability both in a
Finnish occupational cohort,\textsuperscript{21} the US National Health and
Nutrition Examination Survey,\textsuperscript{22} and in Swedish birth cohorts.\textsuperscript{23}

The ‘compression of morbidity’ hypothesis\textsuperscript{8} leads to the
assumption that the mechanism by which disability might be
reduced is through reducing or postponing the incidence of
chronic diseases. Previous studies examining the role of lifestyle

\begin{table}[h]
\centering
\caption{Relative odds of having adverse lifestyle characteristics at baseline by disease and locomotor disability status 12–14 years later (Q92), adjusting for each of the other factors. Disease free, disability-free men form the reference group.}
\label{tab:lifestyle_characteristics}
\begin{tabular}{lccc}
\hline
\multicolumn{1}{c}{Disease status} & \multicolumn{1}{c}{Disability status} & \multicolumn{1}{c}{Status at follow-up 12–14 years after screening (Q92)} & \\
 & (No.) & Disease free & Major cardiovascular disease & Other disease \\
\hline
Baseline characteristic & & & & \\
Manual social class & 1.0 & 0.9 (0.6–1.3) & 0.8 (0.7–1.0) & 1.5 (1.2–1.8) & 0.9 (0.8–1.1) & 1.6 (1.3–1.9) \\
Current smoker & 1.0 & 1.7 (1.2–2.3) & 1.4 (1.1–1.7) & 2.1 (1.7–2.6) & 1.1 (0.9–1.2) & 1.6 (1.4–2.0) \\
Obese (BMI\textsuperscript{a} \geq 28 kg/m\textsuperscript{2}) & 1.0 & 1.6 (1.0–2.5) & 2.0 (1.6–2.6) & 2.5 (1.9–3.2) & 1.4 (1.2–1.7) & 2.3 (1.8–2.9) \\
Physically active & 1.0 & 0.8 (0.6–1.2) & 0.8 (0.7–1.0) & 0.5 (0.4–0.6) & 0.9 (0.8–1.0) & 0.6 (0.5–0.7) \\
Heavily drinking & 1.0 & 1.4 (0.8–2.3) & 1.1 (0.7–1.5) & 1.5 (1.1–2.1) & 1.3 (1.0–1.7) & 1.6 (1.2–2.1) \\
\hline
\end{tabular}
\begin{tablenotes}
\item \textsuperscript{a} Disability free.
\item \textsuperscript{b} Locomotor disability.
\item \textsuperscript{c} Body mass index.
\end{tablenotes}
\end{table}

\begin{table}[h]
\centering
\caption{Relative odds of having adverse baseline characteristics comparing disabled with able men within disease groups at follow up 12–14 years after screening (Q92) adjusting for each of the other factors.}
\label{tab:baseline_characteristics}
\begin{tabular}{lcccc}
\hline
\multicolumn{1}{c}{Follow-up 12–14 years later in 1992} & \multicolumn{1}{c}{Other diseases} & \multicolumn{1}{c}{Respiratory disease} & \multicolumn{1}{c}{Major cardiovascular disease} & \\
\multicolumn{1}{c}{(No. disabled/No. of men)} & (442/1972) & (319/909) & (514/1080) & \\
\hline
Baseline characteristic & & & & \\
Manual social class & 1.8 & 1.5 (1.1–2.1) & 1.8 (1.4–2.3) \\
Current smoking & 1.3 & 2.0 (1.5–2.7) & 1.6 (1.2–2.0) \\
Obese (BMI\textsuperscript{a} \geq 28 kg/m\textsuperscript{2}) & 1.6 & 2.0 (1.3–2.9) & 1.3 (0.9–1.7) \\
Physically active & 0.6 & 0.8 (0.6–1.1) & 0.5 (0.4–0.7) \\
Heavily drinking & 1.0 & 1.5 (0.9–2.3) & 1.5 (1.0–2.2) \\
\hline
\end{tabular}
\begin{tablenotes}
\item \textsuperscript{a} Body mass index.
\end{tablenotes}
\end{table}
risk factors on disability have supported this view that reduction in risk factors lead to a reduction in disease prevalence and that this would result in disability becoming less prevalent.\textsuperscript{7,8,10} Certainly, downward secular trends in cardiovascular disease risk\textsuperscript{24} and associated risk factors\textsuperscript{25} would support this hypothesis, and might be expected to result in a downward trend in disability. However, despite diminishing rates of cardiovascular disease, secular trends in England between 1976 and 1991 show no clear pattern of decline in the proportions of older people reporting locomotor disability sufficient to prevent getting outdoors. By contrast, more severe disabilities resulting in problems with self-care, rather than locomotor disability, have declined quite markedly over this short time.\textsuperscript{26} Our data show that disability is more common in those with diagnosed disease, but importantly, even in men with cardiovascular disease, two-thirds do not report locomotor disability. It is likely that specific diseases are more strongly associated with particular types of disability and a general pattern of association does not occur.

Disability in the absence of chronic disease

Among men with no diagnosed chronic diseases, a small proportion (8.9\%) reported suffering locomotor disability. In these men, the explanation for their disability is difficult to find as there are too few for meaningful analysis, but their risk factor profile is very similar to men with disability in the presence of either cardiovascular disease or other diseases (Table 4), supporting the evidence from our comparisons between and within disease groups (Tables 5 and 6) which suggests that these lifestyle factors operate independently of disease status.

Mechanisms

The mechanisms that might explain such an association need further exploration. Exposure to adverse lifestyle factors may simply make common chronic diseases more severe when they occur. For example, some adverse lifestyle factors (physical inactivity but not smoking) are associated with a higher case fatality among those suffering a myocardial infarction.\textsuperscript{27} It is also possible that adverse lifestyle factors operate by adding to changes associated with ageing, such as reduced muscle mass and strength\textsuperscript{28} and reduced lung expiratory volume\textsuperscript{29} which are independent of manifest disease. In the face of reduced strength and stamina, obesity might be expected to make locomotor disability more apparent. In older women, it has been shown that a decrease in body weight of about 5 kg more than halves the subsequent risk of symptomatic knee osteoarthritis a decade later.\textsuperscript{30} Smoking is known to accelerate age-related declines in lung expiratory volumes\textsuperscript{29} and consequently current smokers may have less ventilatory functional reserve capacity and more readily become breathless on walking and thus disabled. Physical activity may have a protective effect through direct conditioning effects on the locomotor system independent of disease, and these have been demonstrated in intervention trials of physical activity, even in very old age, where improvements in locomotor disability have been achieved.\textsuperscript{31,32}

Social class

Social class differences in locomotor disability are less straightforward and may be explained by occupation-related problems or material deprivation. Manual workers might be exposed to greater ‘wear and tear’ than non-manual workers and consequently be at greater risk of disability, or suffer disability associated with occupational exposures not fully accounted for in our analyses. Use of health services and social care, which may vary by social class, might be expected to have an impact on disability. Manual workers may be less likely to seek health care for acute and chronic illnesses, many of which may be treatable with improvements in disability. For example, treatment of heart failure improves functional ability.\textsuperscript{33}

Sources of bias

The prevalence of locomotor disability reported by the men in this study is similar to estimates from a British national survey of disability\textsuperscript{2} in which 3.1\% and 19.5\% of adults aged 16–59 and 60–74, respectively, reported locomotor disability. It might be expected that selection effects due to non-response or death prior to Q92 assessment would result in our sample having a lower prevalence of disability. However, the comparability with this national survey suggests that biased ascertainment of those with locomotor disability has not occurred. The American Established Populations for the Epidemiological Study of the Elderly cohorts have demonstrated that disability is not a static state; people become disabled, may then die, or may make a partial or complete recovery.\textsuperscript{34} In this study we only have information about disability at a single time point and we have no data on the timing of onset of disability. Consequently, we can only examine the relationship between baseline risk factors and subsequent prevalence of disability and this may introduce biases into our estimates of strength of association. Selective attrition through death of the most disabled and those with the most adverse risk factor profiles is the most likely bias but this would tend to attenuate the associations observed. Bias in reporting of locomotor disability and disease is unlikely to affect our findings as lifestyle and other risk factors were measured 12–14 years prior to the assessments of disability and disease status. However, as our study was originally established to examine causes of cardiovascular disease it is likely that these are recorded and reported more accurately than other diseases and health problems examined in this report. However, self-reports of locomotor and other forms of disability show reasonable validation when compared with other sources of information such as interviews, physician and other health staff assessments.\textsuperscript{35} It seems unlikely that misclassification of causes of disability has had a marked effect on our findings. Analyses excluding men with co-morbidities other than cardiovascular disease did not alter the relationships between risk factors and disability among those men with cardiovascular disease (Table 6).

Prevention

By the age of 80 years, four out of five people have some self-reported disability\textsuperscript{2} implying major public health impacts for the British population who now have an average life expectancy of over 80 years.\textsuperscript{36} Prevention of disability in older people requires multiple approaches. Our data support the concept that disability may be improved by focusing not only on disease itself (e.g. prevention, treatment and palliation of cardiovascular disease), but also by modification of individual lifestyle risk factors (e.g. smoking, obesity, physical inactivity, heavy drinking). Further work will be required to explore the extent to which changes in lifestyle and other risk factors lead to the
prevention of or improvement in disability.\textsuperscript{37} It is likely that the best estimates of effects of such interventions will be obtained from observational cohort studies as trials in these areas of health promotion through lifestyle modification are difficult to conduct and interpret.\textsuperscript{38}

### Conclusion

Lifestyle factors are important causes of cardiovascular disease and their modification has been clearly shown to reduce the incidence of disease\textsuperscript{39–42} and to increase the chances of survival free of cardiovascular disease.\textsuperscript{43} These new findings demonstrate that leading a healthy lifestyle by maintaining moderate levels of physical activity, and avoiding obesity, heavy drinking and smoking are rewarded by a lower risk of locomotor disability and increased odds of being disability-free even in the event of developing major cardiovascular disease.

### Acknowledgements

This work was supported by programme grants from the British Heart Foundation and the Department of Health.

### References


