SUMMARY. This article uses data from the United Kingdom Medical Research Council Cognitive Function and Ageing study (MRC CFAS) to analyze morbidity associated with three areas of impairment. We use cognitive status, functional status, and physical illness to examine differences in the proportion of time that older women and men will spend with co-morbidity. We also analyze differences among various impairments, and investi-
gate the relationship between missing data and sex. Women have a larger burden of impairment than men, and, by including cognitive impairment together with functional impairment, a very large impairment burden is highlighted at all ages. Policy implications of the findings from the perspective of older women in the United Kingdom are discussed. [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.HaworthPress.com> © 2002 by The Haworth Press, Inc. All rights reserved.]

KEYWORDS. Cognitive impairment, functional status, missing data, health expectancy

INTRODUCTION

The process of disablement with ageing has tended to be focussed at the point where there is an impact on the daily life activities of older people, the so-called Activities of Daily Living (ADLs) (Katz, Ford, Moskowitz, Jackson, and Jaffe, 1963) based on personal care items and Instrumental Activities of Daily Living (IADLs) which are concerned with household level activities such as shopping and cooking (Lawton and Brody, 1969). There have been a number of major models of the disablement process (Nagi, 1965; Wood, 1975; World Health Organization, 1980; Nagi, 1991; Verbrugge and Jette, 1994) with each distinguishing between a maximum of five states: disease; impairments; functional limitations; activity restriction; and handicap, the major differences being in distinguishing states later in the sequence and particularly the distinction between functional limitations and activity restriction. A key point is that all these models agree on the position of diseases and impairments on the disablement process. Nagi (1965) defined impairments as anatomical, physiological, intellectual or emotional abnormalities, or losses and noted that, despite their position in the process after disease, impairments do not always imply a disease in the sense of active pathology.

Impairments are thus an important stage in the disablement process and older ages are often characterized by the higher prevalence of these, particularly cognitive impairments. Women tend to exhibit a higher prevalence of cognitive impairments than men. As the evidence for differences in incidence are less strong (Fratiglioni et al., 2000), this may in part be due to their longer survival with dementia (Jagger, Clarke, and Stone, 1995).
The area of mental health expectancy has received less attention than health expectancies based on measures of physical function, usually disability based on ADL restrictions, and has tended to be centred around disease, in terms of dementia-free life expectancy (Ritchie, Robine, Letenneur, and Dartigues, 1994; Jagger et al., 1998; Sauvaget, Tsuji, Haan, and Hisamichi, 1999). We present data from a very large multi-centre study to examine the differential time spent with cognitive and functional impairments and with physical illness between women and men in the United Kingdom. A previous paper (MRC CFAS, 2001) presented each type of impairment and the burden on the population but an important problem in such studies of cognitive impairment, and indeed of almost all studies of the very old, is that of non-response or response by a proxy, which results in larger quantities of missing data. Impairment in one dimension may influence missing data in another dimension and hence we also investigate the degree to which the current estimates of the impairment burden are influenced by differential amounts of missing data by sex within the impairments investigated.

METHODS

The MRC Cognitive Function and Ageing study (MRC CFAS) is a multi-centre prospective cohort study. Set up in 1989 by the Medical Research Council (MRC) and the Department of Health (DoH), its aim is to study ageing, cognitive function, and dementia across England and Wales. The core study had five methodologically similar centres (Cambridgeshire, Gwynedd, Newcastle, Nottingham, Oxford) and one centre (Liverpool) that was funded earlier but has a slightly different design. The five centres selected a stratified random sample from Family Health Service Authority lists of sufficient individuals aged 65 years and over to achieve at least 2,500 interviews at each centre. Respondents were screened with a basic interview and approximately 20% were selected on the basis of age and cognitive performance to receive a more detailed clinically orientated assessment interview one to two months later. This paper uses data from the five methodologically similar centres with a total sample size of 13,009 adults aged 65 years and over (data version 3.1); full details have already been reported (MRC CFAS, 1998).

Respondents were interviewed in their homes using laptop computers with immediate entry of response codes about marital status, accommodation, occupation (for social class), social networks (Wenger, 1989), ADLs (Bond and Carstairs, 1982), cognitive function (Folstein, Folstein,
and McHugh, 1975; MRC, 1987), the organicity section questions from the Geriatric Mental State Examination (Copeland, Dewy, and Griffiths-Jones, 1986), medication and physical health questions relevant to dementia and cognitive health (Launer, Brayne, and Breteler, 1992). Signed informed consent was obtained from the respondent or from a proxy where appropriate.

Three types of impairment are considered: functional, based on the Townsend disability scale (maximum 18 points) with a cut point of 11 or above indicating functional impairment and equating to standard methods (Townsend, 1979); cognitive impairment, defined as a score below 18 on the Mini-Mental State Examination (MMSE) (Brayne and Calloway, 1990); and physical impairment, taken as being the presence of any of the conditions (stroke, heart attack, angina, high blood pressure, peripheral vascular disease, transient ischaemic attacks, severe hearing or visual problems, epilepsy, asthma [except childhood only], chronic bronchitis, Parkinson’s disease, depression, and arthritis).

The interview was designed so that in cases of severe cognitive impairment, or where the interviewer considered the respondent was not able to answer the entire interview, a subset of questions could be asked; this decision could be made at any time by either the interviewer, the proxy, or the respondent. In this “priority interview,” questions concentrated on cognition and did not include functional impairment or health. Proxy interviews were also permitted for all sections, except cognition, which would therefore be missing in these instances.

**Statistical Methods**

The proportion of individuals in each age and sex group were tabulated as suffering from none, one, two, or all three of these impairment dimensions. People with missing values were those who had already reached the threshold for impairment, or where the threshold could not be crossed regardless of the possible responses to the missing data. Health expectancies were then calculated combining the prevalence with mortality data (OPCS, 1993) using the Sullivan method (Sullivan, 1971), and with life expectancies calculated up to the age of 90 years in single years of age. Those with missing data were included as impaired in one analysis to investigate the extent to which gender differences found could be explained by differential amounts of missing information.
RESULTS

A total of 7,849 women and 5,160 men had the basic screening interview that provided information on the three areas of impairment. Table 1 shows the prevalence of the three impairments by five-year age group and the degree of missing data. Below 80 years of age, women exhibited greater rates of physical and functional impairment than men but similar levels of cognitive impairment. Missing data was relatively rare in these age groups. Rates of cognitive and functional impairment rose with age for both sexes and after age 80 women had substantially higher rates than men. The relationship between age and physical impairment was less clear with older women having very similar levels of physical impairment to men of the same age. Missing data for each impairment increased with age with a tendency for there to be more missing data for women than men in each age group. The remaining life expectancy for women was almost four years more than for men in the youngest age group (65-69 years) decreasing to 0.6 years in the highest age group (90+ years) (Table 1).

Impairment combinations are shown in Table 2. Physical impairment was both the most common single impairment, and together with functional impairment, the most common shared impairment combination. Physical impairment alone was the most common condition in both sexes and at all ages, except in women aged 90+ where physical impairment and

<table>
<thead>
<tr>
<th>Age</th>
<th>No. Cognitive impairment</th>
<th>Functional impairment</th>
<th>Physical impairment</th>
<th>Life expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women 65-69</td>
<td>1,743 1 (&lt;1)</td>
<td>5 (&lt;1)</td>
<td>84 (&lt;1)</td>
<td>17.8</td>
</tr>
<tr>
<td>70-74</td>
<td>1,763 2 (&lt;1)</td>
<td>5 (&lt;1)</td>
<td>85 (&lt;1)</td>
<td>14.2</td>
</tr>
<tr>
<td>75-79</td>
<td>1,748 2 (1)</td>
<td>11 (2)</td>
<td>86 (2)</td>
<td>10.9</td>
</tr>
<tr>
<td>80-84</td>
<td>1,477 11 (3)</td>
<td>22 (7)</td>
<td>85 (5)</td>
<td>8.0</td>
</tr>
<tr>
<td>85-89</td>
<td>792 19 (5)</td>
<td>33 (11)</td>
<td>84 (7)</td>
<td>5.7</td>
</tr>
<tr>
<td>90+</td>
<td>326 37 (10)</td>
<td>46 (24)</td>
<td>81 (13)</td>
<td>3.9</td>
</tr>
<tr>
<td>Men 65-69</td>
<td>1,444 1 (&lt;1)</td>
<td>3 (&lt;1)</td>
<td>80 (&lt;1)</td>
<td>14.1</td>
</tr>
<tr>
<td>70-74</td>
<td>1,386 2 (&lt;1)</td>
<td>4 (1)</td>
<td>81 (1)</td>
<td>11.0</td>
</tr>
<tr>
<td>75-79</td>
<td>1,160 4 (&lt;1)</td>
<td>8 (2)</td>
<td>85 (1)</td>
<td>8.4</td>
</tr>
<tr>
<td>80-84</td>
<td>778 5 (2)</td>
<td>12 (2)</td>
<td>86 (2)</td>
<td>6.3</td>
</tr>
<tr>
<td>85-89</td>
<td>302 14 (3)</td>
<td>19 (9)</td>
<td>83 (5)</td>
<td>4.6</td>
</tr>
<tr>
<td>90+</td>
<td>90 18 (3)</td>
<td>38 (14)</td>
<td>80 (6)</td>
<td>3.3</td>
</tr>
</tbody>
</table>
functional impairment was equally common (28% compared with 30% respectively). Since by definition the row percentages in Table 2 sum to 100%, including the missing data as impaired resulted in changes across all the impairment combinations and had the most effect at the oldest ages and with three impairment combinations. These results were similar in both men and women with the pattern of impairment combinations remaining substantially the same whether the missing data was excluded or included. However, excluding the missing data suggests that the impairment burden could be underestimated, particularly in women and in the oldest age groups.

When all those with missing information and not already deemed impaired were excluded, women appear to spend more absolute years and a longer proportion of their remaining life with impairments than men (Figure 1). For example a 70-year-old woman had a total life expectancy of 14.2 years with 1.6 years with no impairment (11%), 9.9 years with one impairment (70%), 2.3 years with two impairments (16%), and 0.5 years with three impairments (3%). By age 85 years, women could expect to spend 11% of remaining life impaired physically, functionally, and cognitively compared to 4% of the remaining life for men. Including those with missing data as impaired increased these figures for both men and women (to 25% for women and 15% for men), but had negligible effect on the gender differential (Figure 2).

**DISCUSSION**

This study clearly shows the impact of cognitive, functional, and physical impairments on older men and women with women spending a greater proportion of their remaining life with impairment. A major problem faced by studies of ageing are the increasing levels of cognitive impairment with age, often resulting in significant amounts of missing data for other self-report measures. In general, this is dealt with in analyses by reporting comparisons of those with missing data and those without on broad demographic characteristics, such as age and sex and then excluding those with missing data in subsequent analyses. Because of the nature of our study, missing data was predominantly due to impaired cognitive function, with greater amounts of missing data for women compared to men of the same age. Comparison of the effect of excluding those with missing data with including them as impaired showed that the gender differentials in the proportion of life expectancy with impairment were rela-
TABLE 2. Percentage of the Study Population by Each Impairment Combination by Age and Sex, Missing Excluded and Missing Included as Impaired (in Parentheses)¹

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Physical</th>
<th>Functional</th>
<th>Cognitive</th>
<th>Physical &amp; Functional</th>
<th>Physical &amp; Cognitive</th>
<th>Functional &amp; Cognitive</th>
<th>All three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women 65-69</td>
<td>29 (29)</td>
<td>66 (65)</td>
<td>&lt;1 (&lt;1)</td>
<td>&lt;1 (&lt;1)</td>
<td>4 (4)</td>
<td>&lt;1 (&lt;1)</td>
<td>0 (&lt;1)</td>
<td>&lt;1 (1)</td>
</tr>
<tr>
<td>70-74</td>
<td>26 (26)</td>
<td>68 (67)</td>
<td>1 (1)</td>
<td>&lt;1 (&lt;1)</td>
<td>4 (5)</td>
<td>1 (1)</td>
<td>&lt;1 (&lt;1)</td>
<td>&lt;1 (1)</td>
</tr>
<tr>
<td>75-79</td>
<td>24 (24)</td>
<td>63 (62)</td>
<td>1 (1)</td>
<td>&lt;1 (1)</td>
<td>10 (10)</td>
<td>1 (1)</td>
<td>&lt;1 (&lt;1)</td>
<td>1 (3)</td>
</tr>
<tr>
<td>80-84</td>
<td>19 (18)</td>
<td>54 (50)</td>
<td>2 (2)</td>
<td>1 (1)</td>
<td>17 (17)</td>
<td>2 (3)</td>
<td>1 (1)</td>
<td>3 (10)</td>
</tr>
<tr>
<td>85-89</td>
<td>13 (11)</td>
<td>45 (39)</td>
<td>2 (2)</td>
<td>2 (2)</td>
<td>26 (24)</td>
<td>5 (5)</td>
<td>1 (1)</td>
<td>6 (16)</td>
</tr>
<tr>
<td>90+</td>
<td>8 (6)</td>
<td>28 (20)</td>
<td>7 (5)</td>
<td>1 (1)</td>
<td>30 (23)</td>
<td>5 (4)</td>
<td>3 (3)</td>
<td>18 (39)</td>
</tr>
<tr>
<td>Men 65-69</td>
<td>29 (29)</td>
<td>67 (67)</td>
<td>&lt;1 (&lt;1)</td>
<td>&lt;1 (&lt;1)</td>
<td>3 (3)</td>
<td>&lt;1 (&lt;1)</td>
<td>0 (&lt;1)</td>
<td>&lt;1 (1)</td>
</tr>
<tr>
<td>70-74</td>
<td>28 (27)</td>
<td>67 (66)</td>
<td>&lt;1 (&lt;1)</td>
<td>&lt;1 (&lt;1)</td>
<td>4 (4)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>&lt;1 (1)</td>
</tr>
<tr>
<td>75-79</td>
<td>23 (22)</td>
<td>67 (65)</td>
<td>1 (1)</td>
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<td>6 (7)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>1 (3)</td>
</tr>
<tr>
<td>80-84</td>
<td>19 (19)</td>
<td>67 (64)</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>10 (10)</td>
<td>2 (2)</td>
<td>0 (0)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>85-89</td>
<td>18 (16)</td>
<td>58 (52)</td>
<td>1 (2)</td>
<td>1 (1)</td>
<td>15 (14)</td>
<td>3 (3)</td>
<td>1 (1)</td>
<td>3 (12)</td>
</tr>
<tr>
<td>90+</td>
<td>15 (12)</td>
<td>41 (34)</td>
<td>5 (4)</td>
<td>0 (0)</td>
<td>29 (28)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>8 (20)</td>
</tr>
</tbody>
</table>

¹Within sex and age group, row percentages for missing excluded sum to 100 as do those for missing included as impaired (percentages in parentheses).
tively unaffected and, therefore, were not a result of differential amounts of missing data between men and women.

To date, health expectancies have tended to focus on physical health measures such as disability-free life expectancies with many fewer studies reporting health expectancies based on measures of mental health or indeed on combinations of impairments as reported here. Estimates of life
expectancy spent with dementia appear to be similar from studies across Europe and relatively static with age, at around one year for women and half a year for men (Jagger et al., 1998). However, most of the studies reported have included relatively few of the very old (aged 90 years and over) and hence it is difficult to predict whether these estimates remain static over the entire age range. The only comparable study, from Melton
Mowbray, England (Jagger et al., 1991), reported life expectancy with cognitive impairment, using the MMSE with a cut point of 24 and scoring those unable to answer as impaired on each item of the MMSE. Despite the less severe levels of cognitive impairment detected, women again showed significantly greater proportions of remaining life spent with cognitive impairment (Bone et al., 1995). Measures of physical and functional impairment in the Melton Mowbray study were, however, not directly comparable with MRC CFAS.

The measures used here had different sensitivities to the impairment types. Physical impairment was the presence of one of many self-reported conditions and hence current physical disability cannot be assumed. Cognitive and functional impairments were considered on a cut-point of a well-used ordinal scale measured at the time of interview. No severity information could be incorporated for the physical impairment to attempt to address this discrepancy; however, severity could be examined for both functional and cognitive impairment.

We found all three impairments to be more common in women than in men, consistent with other studies (e.g., Ferrucci et al., 1999; Crimmins, Hayward, and Saito, 1996; Tsuji et al., 1995). These findings have important policy implications since, as women are more likely to be widowed and live alone than are men, the bulk of the care needs falls to children, neighbours, and the formal health and social care services. This is more problematic when the woman is cognitively impaired since care needs are not as predictable and there is a greater likelihood of a move into residential care. Moreover, the strong relationship between the prevalence of cognitive impairment and age means that, as life expectancies continue to increase, the numbers of women with cognitive impairment will increase.

A further effect of the higher prevalence of cognitive impairment in women over men was that women had a larger amount of missing data. However, including the missing data as impaired changed the gender differences only marginally but had a considerable effect on the proportion of life spent with impairments for women and men. In most studies, missing data is not usually included and this could underestimate effects, particularly in the women. Our findings suggest that using studies where considerations of missing data have not been made, to project future health and care needs, would result in considerable underestimates of the burden on services with major implications for health planners and policy-makers.

Including measures of cognitive impairment into active life expectancy has been shown to significantly decrease estimates of active life expectancy by 6.8% in men aged 65 years and 10.1% in women (Gallo, Schoen,
Cognitive impairment has been shown to be an important precursor to the subsequent development of activity restriction in older people (Wood, 1975; Moritz, Kasl, and Berkman, 1995). Thus, combining measures of earlier and later stages in the disablement process will simply reflect the greater range of severity detected. Keeping the measures separate and estimating health expectancies based on each stage of the disablement process will instead help to elucidate scenarios like that of dynamic equilibrium (Manton, 1982). In this case, trends in disability of all levels remains static, though this hides increases in less severe disability over time together with falls in the more severe levels of disability. In addition, further longitudinal data to establish how impairments impact on the disablement process, particularly on social functioning and the need for care will provide a better picture of the future needs of older men and women in our populations and the relationship between this process and death.

REFERENCES


