Impact of Chronic Diseases on Functional Limitations in Elderly Chinese Aged 70 Years and Over: A Cross-Sectional and Longitudinal Survey

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Objective. To examine the association of some common medical conditions with functional limitation in elderly Chinese aged 70 years and over, to estimate the percentage of disability attributable to individual diseases, and to attempt to identify predisposing factors by documenting the development of functional limitation over an 18-month period in those subjects with a particular disease who were independent initially.

Subjects and Method. The cross-sectional data set consisted of 2,032 (999 M, 1,033 F) subjects aged 70 years and over recruited by random sampling (stratified by age and sex) of all recipients of old-age and disability allowance, which covers over 90% of the elderly population. Information regarding medical condition and functional assessment of ten basic activities of daily living using the Barthel Index were obtained by personal interviews and physical assessment of the respondents at their places of residence. The longitudinal data set consisted of 1,334 subjects with no functional limitation at baseline who were alive after 18 months. Functional status was reassessed.

Results. After adjusting for age and sex, diseases associated with severe functional limitation (Barthel Index <15) were dementia, stroke, Parkinson’s disease, and fractures. Those associated with mild to moderate functional limitation (Barthel Index 15–19) were the same, with the addition of asthma and diabetes mellitus. The attributable fraction for severe limitation was highest for stroke, dementia, and fractures. Stroke and arthritis were identified as diseases predisposing to mild to moderate functional limitation over an 18-month period among those subjects who were independent initially.

Conclusion. Stroke, dementia, and fractures were the main chronic diseases associated with severe functional limitation in elderly Hong Kong Chinese. Attempts to reduce the disability burden in this population should target these diseases.

With the aging of population in many countries, increasing attention is drawn to the rising health care costs as a result of the increased prevalence of many diseases with age. Apart from costs of hospitalization and drug expenditures, a proportion of the costs arises from disability or functional limitations attributable to diseases. The impact of functional limitation may be measured in terms of resources required from health and social service providers, as well as quality of life for individuals. Therefore it is important to examine the relationship between disease and disability. Identification of medical conditions associated with the most functional limitations would enable more accurate estimates of the potential benefits of intervention or disease prevention methods. In recent years, population studies have examined different aspects of the relationship between diseases and disability in the community (1–4) as well as in nursing homes (5). Some are cross-sectional studies, which only examine associations, while longitudinal studies will identify predisposing factors.

As in other Western countries, the population in Hong Kong is also aging, with the proportion of the population aged 65 years and over increasing from 2.8% in 1961 to 8.8% in 1991, and to a projected figure of 15% by 2001. The average life expectancy is 77 years for men and 82 years for women. Among those aged 70 years and over, the prevalence of impairment in different activities of daily living varies from 1% for grooming to 26% for climbing stairs. There is no information regarding the association of chronic diseases with functional limitation, nor on the proportion of functional limitation attributable to different diseases. The aims of the present study are to examine the association of some common medical conditions with functional limitation in elderly Chinese aged 70 years and over, to estimate the percentage of disability attributable to individual diseases, and to attempt to identify diseases predictive of disability by documenting the development of functional limitation over an 18-month period in those subjects with a particular condition who are independent initially.

Subjects and Method

Subjects were recruited as part of a population survey of the social and health profile of elderly Chinese aged 70 years and over. They were selected by stratified random sampling from a registered list of all recipients of Old Age and Disability Allowance in Hong Kong. The Old Age Allowance list covers over 90% of the elderly aged 70 years and over, as eligibility is by age alone, independent of income. Subjects were stratified by age and sex so that there would be sufficiently large numbers of subjects in the 80–84, 85–89, and 90+ age groups in each sex. Details of the sampling method
have been reported in other papers (6,7). The overall response rate was 60%. There was no significant difference in age between responders and nonresponders.

Data collection was done through both personal interviews and physical assessment of the respondents at the subjects' places of residence. The structured questionnaire administered contained information on medical history as well as functional status. Subjects or their caretakers were asked whether they had the following medical conditions, based on consultation with physicians: stroke, Parkinson’s disease, heart disease (ischemic heart disease or heart failure), chronic bronchitis or emphysema, asthma, diabetes mellitus, arthritis, fractures, or dementia. Functional status was assessed using the Barthel Index (8), which has a maximum score of 20. It assesses competence in 10 activities of daily living: feeding, grooming, dressing, toileting, transfer, continence of urine and bowel, walking, climbing stairs, and bathing. A score of <15 was used to indicate severe limitation, 15–19 to represent moderate-to-mild limitation, and 20 to represent no limitation.

Interviewers were registered nurses, medical students, and doctors, trained by three of the authors (Y.K.Y., J.W., S.C.H.). For subjects from whom information could not be directly obtained because of poor cognitive function or illness, the proxy was interviewed instead. The proxy was the main caretaker for those living in the community, and a staff member of the nursing home for those living in institutions.

A follow-up survey was conducted 18 months later, when the functional status was reassessed, and any deaths were noted.

Chi-square test was used to detect any age and sex difference in the prevalence of diseases. Logistic regression was used to calculate the odds ratio for functional limitation for individual diseases, adjusting for age and sex, for the baseline data. Severe limitation and mild to moderate limitation were analyzed separately as the dependent variables. The percentage of disability attributable to individual diseases after controlling for age and sex (attributable fraction) was calculated using the formula (9): Attributable fraction = [P(OR - 1) • OR], where P is the proportion of subjects with functional limitation, and OR is the odds ratio for functional limitation adjusted for age and sex.

For the longitudinal data, subjects who had no functional limitation at baseline were examined. Logistic regression was used to calculate the odds ratio (age- and sex-adjusted with age entered as a continuous variable) for developing functional limitation after 18 months for individual diseases.

**Results**

The baseline sample consisted of 2,032 subjects (M = 999; F = 1,033). At 18 months, 237 subjects had died, and 130 subjects were lost to follow-up. These were excluded from analysis of the longitudinal data, leaving 1,665 subjects in the follow-up data set. Among these, 1,334 had no functional limitation at baseline. For those subjects lost to follow-up, the proportion of subjects who were independent at baseline was also 80%.

Table 1 shows the age and sex differences in the prevalence of nine chronic diseases. A significant increase in prevalence with age was observed for stroke and dementia. Heart disease, diabetes, arthritis, and fractures were more prevalent in women, whereas chronic bronchitis/emphysema was more prevalent in men. After adjusting for age and sex, the odds ratio for occurrence of severe functional limitation was highest for dementia, stroke, and Parkinson’s disease (Table 2). However, some of the confidence intervals were very wide, due to small numbers. Fractures, asthma, and diabetes mellitus were also significantly associated with mild to moderate functional limitations, and fractures were associated with severe limitation, in addition. Heart disease, chronic bronchitis/emphysema, and arthritis were not associated with functional limitations in the cross-sectional analysis. For the population as a whole, the highest percentage of severe limitation was attributable to stroke, dementia, and fractures. For mild to moderate functional limitations, the highest percentage was attributable to stroke and fractures (Table 3).

Of the 1,334 subjects with no functional limitations initially, 262 developed functional impairment. Only stroke and arthritis were identified as significant conditions predisposing to mild to moderate functional limitation over an 18-month period (Table 4).

### Table 1. Prevalence of Chronic Diseases by Age and Sex

<table>
<thead>
<tr>
<th>Disease</th>
<th>Men 70–79 yrs (n = 596)</th>
<th>80 + yrs (n = 403)</th>
<th>Total (n = 999)</th>
<th>Women 70–79 yrs (n = 576)</th>
<th>80 + yrs (n = 457)</th>
<th>Total (n = 1,033)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke*</td>
<td>38 (6.4)</td>
<td>33 (8.2)</td>
<td>71 (7.1)</td>
<td>42 (7.3)</td>
<td>49 (10.7)</td>
<td>91 (8.8)</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>8 (1.3)</td>
<td>4 (1.0)</td>
<td>12 (1.2)</td>
<td>5 (0.9)</td>
<td>5 (1.1)</td>
<td>10 (1.0)</td>
</tr>
<tr>
<td>Heart disease</td>
<td>93 (15.6)</td>
<td>67 (16.6)</td>
<td>160 (16.0)</td>
<td>118 (20.5)</td>
<td>87 (19.0)</td>
<td>205 (19.8)</td>
</tr>
<tr>
<td>Chronic bronchitis/emphysema</td>
<td>68 (11.4)</td>
<td>40 (9.9)</td>
<td>108 (10.8)</td>
<td>34 (5.9)</td>
<td>23 (5.0)</td>
<td>57 (5.5)</td>
</tr>
<tr>
<td>Asthma</td>
<td>36 (6.0)</td>
<td>25 (6.2)</td>
<td>61 (6.1)</td>
<td>24 (4.2)</td>
<td>20 (4.4)</td>
<td>44 (4.3)</td>
</tr>
<tr>
<td>Diabetes mellitus*</td>
<td>52 (8.7)</td>
<td>34 (8.4)</td>
<td>86 (8.6)</td>
<td>83 (14.4)</td>
<td>41 (9.0)</td>
<td>124 (12.0)</td>
</tr>
<tr>
<td>Arthritis*</td>
<td>181 (30.4)</td>
<td>107 (26.6)</td>
<td>288 (28.8)</td>
<td>265 (46.0)</td>
<td>176 (38.5)</td>
<td>441 (42.7)</td>
</tr>
<tr>
<td>Fractures</td>
<td>69 (11.6)</td>
<td>46 (11.4)</td>
<td>115 (11.5)</td>
<td>104 (18.1)</td>
<td>88 (19.3)</td>
<td>192 (18.6)</td>
</tr>
<tr>
<td>Dementia**</td>
<td>4 (0.7)</td>
<td>10 (2.5)</td>
<td>14 (1.4)</td>
<td>7 (1.2)</td>
<td>19 (4.2)</td>
<td>26 (2.5)</td>
</tr>
</tbody>
</table>

**Notes:** Significant difference between 70–79 yrs age group and 80+ yrs age group: *p < .05; **p < .001.

Significant difference between male and female: †p < .05; ‡p < .001.
Table 2. Odds Ratio for Functional Limitation Adjusted for Age and Sex

<table>
<thead>
<tr>
<th>Disease</th>
<th>Severe limitation (Barthel Index &lt; 15 vs independent)</th>
<th>Mild to moderate limitation (Barthel Index 15-19 vs independent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio (95% CI)</td>
<td>p value</td>
</tr>
<tr>
<td>Stroke</td>
<td>19.3 (12.2-30.4)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>14.2 (4.9-41.3)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Asthma</td>
<td>1.4 (0.6-3.2)</td>
<td>.39</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.7 (1.0-3.0)</td>
<td>.07</td>
</tr>
<tr>
<td>Old fractures</td>
<td>2.5 (1.6-3.8)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Dementia</td>
<td>157.1 (47.0-528.0)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Table 3. Percentage of Disability Attributable to Individual Diseases After Controlling for Age and Sex

<table>
<thead>
<tr>
<th>Disease</th>
<th>Severe functional limitation (Barthel Index &lt; 15)</th>
<th>Mild to moderate limitation (Barthel Index 15-19)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>AF</td>
</tr>
<tr>
<td>Stroke</td>
<td>41.9</td>
<td>39.7</td>
</tr>
<tr>
<td>Dementia</td>
<td>23.3</td>
<td>23.2</td>
</tr>
<tr>
<td>Old fractures</td>
<td>28.2</td>
<td>16.9</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>6.1</td>
<td>5.7</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>13.8</td>
<td>5.7</td>
</tr>
<tr>
<td>Asthma</td>
<td>5.9</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Notes: P, Percentage of functionally limited subjects with specific disease; AF, attributable fraction.

Table 4. Contribution of Some Chronic Diseases to Relative Risk for Functional Limitation After 18 Months in Subjects with Independent Function at Baseline

<table>
<thead>
<tr>
<th>Disease</th>
<th>Severe limitation (Barthel Index &lt; 15 vs independent)</th>
<th>Mild to moderate limitation (Barthel Index 15-19 vs independent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relative Risk* (95% CI)</td>
<td>p</td>
</tr>
<tr>
<td>Stroke</td>
<td>2.3 (0.5-10.5)</td>
<td>0.27</td>
</tr>
<tr>
<td>Arthritis</td>
<td>0.9 (0.4-1.9)</td>
<td>0.79</td>
</tr>
</tbody>
</table>

*Adjusted for age and sex.

DISCUSSION

It has been pointed out that it is mainly diseases that cause disability, and that preventing disease or reducing its consequences is critical to the reduction of disability in a population (1). Identification of chronic medical conditions that contribute most to disability in any population is necessary, so that preventive or interventional efforts may be directed appropriately to reduce the disability burden for that population.

Various methodological problems are encountered in studies addressing this issue. The first is the accuracy of medical diagnosis in large scale community surveys. It may not be possible to have the medical diagnosis made by physicians on the basis of physical examinations and investigations. Even if all subjects underwent medical examinations, some disease may not be diagnosed unless extensive investigations have been performed. This is particularly true in the elderly population where there is a higher proportion with disease who remain asymptomatic or present atypically (10). Most population surveys obtain information regarding medical conditions from the subjects themselves. In some surveys, a sample of the study subjects was re-evaluated by physicians for some of the conditions (2), while detailed investigations were available for all subjects in the Framingham sample (4). From the perspective of population prevalence and health needs studies, information from questionnaires may be sufficient, for certain diseases. For example, it has been shown that “have you ever had a stroke” is a sensitive (95%) and specific (96%) screening question for assessing stroke prevalence (11).

Another problem is the coexistence of more than one condition being examined in some subjects. In this study, we did not examine the effect of comorbidity on functional limitation, but only examined the contribution of individual diseases. Whether subjects who died during longitudinal studies should be included is also debatable. For estimation of disease associated disability burden for a population, it could be argued that because mortality will not add to the disability burden, subjects who died during the follow-up period could be excluded, and this was the rationale for excluding these subjects in the present study. The nine medical conditions were chosen on the basis that they are frequently encountered in the older adults, may result in
functional limitations, and were less likely to give rise to mortality during the follow-up period. Thus, cancer was omitted from this study.

The study sample is representative of the elderly Hong Kong Chinese population, and consisted of large numbers of the old old (age 80 years and over). Unlike other surveys that either studied community dwelling (1-4) or nursing home populations (5), the present study included both groups. There is expected to be a high proportion of subjects with diseases and functional limitations among the nursing home population. Assessment of functional limitation differs between different studies, but most document either basic or instrumental activities of daily living. The Barthel Index, measuring basic activities of daily living, was used in this study as it is widely used clinically and sensitivity to change has been demonstrated in the local Chinese population (12).

Cross-sectional observational studies of the relationship between diseases and functional limitation cannot take into account fluctuations in functional ability, unlike longitudinal surveys. Subjects with limitation may become independent with time. Thus in our study, 90 subjects with initial disability became independent after 18 months, while 262 subjects who were initially independent developed functional limitations. Longitudinal surveys also enable observations regarding cause-effect relationships to be made. However, longitudinal surveys are costly to conduct, and may not be justified if results from cross-sectional studies are similar to longitudinal studies. A review of other surveys suggests that results are similar. Cross-sectional surveys in the United States (4) and China (3) identified stroke, dementia, fractures, cardiopulmonary diseases and diabetes to be associated with functional dependence. Results from a longitudinal study of the United States population are similar (2), identifying stroke and arthritis as the best predictors for dependence over a 4-year period. The contribution of cardiovascular disease approached significance.

The diseases associated with functional limitation noted in this study are similar to studies in the United States and mainland Chinese populations (1-4) with the exception of asthma, which is associated with mild to moderate disability in our population. Unlike studies in the United States, heart disease was not associated with functional limitation. This may be explained by the use of basic activities of daily living as functional assessment in this study, and although subjects with heart disease may have reduced exercise tolerance they could still perform these basic activities. Stroke is identified as the disease contributing the most to functional limitation, both in the cross-sectional and longitudinal data sets. It also contributes the most to severe functional limitation. All studies published to date have consistently identified cerebrovascular disease as a strong predisposing factor. Longitudinal studies have also highlighted stroke and arthritis as the main predictors of functional limitations (2,13,14). Therefore it may be argued that from the public health point of view, the expense of conducting longitudinal studies may not be justified, because similar diseases resulting in dependence are identified, even though longitudinal studies should more correctly be conducted to identify diseases predictive of disability.

The discrepancy between the results from the cross-sectional and the longitudinal data sets for our population was a little unexpected. However, the two data sets were used to address slightly different questions. Only subjects who were independent initially were included in the longitudinal data set, in order to identify diseases predisposing to the development of functional limitations during the 18-month follow-up period. Therefore subjects who already had disability consequent to diseases at baseline would have been excluded and fewer significant associations with diseases would be expected. Moreover, the follow-up period was relatively short, and fewer subjects could be expected to develop severe functional limitations. Nevertheless, the longitudinal data set showed that subjects with stroke and arthritis were at increased risk of functional limitation. A longer follow-up period may well identify stroke as a predisposing factor to severe functional limitation as well, possibly in addition to other diseases. In this study, we cannot demonstrate strict cause-effect relationships, because we did not ask subjects what caused their disability; neither was such an attempt made by the investigators themselves during the study.

This study identified stroke, dementia, and fractures as the main chronic diseases associated with severe functional limitation in elderly Hong Kong Chinese. Future attempts to reduce the disability burden in this population, whether they consist of disease prevention or interventional methods to improve function, should target these diseases. In Hong Kong, for those over 70 years old, the prevalence of dementia is estimated to be 1.6% (15), the incidence of cerebrovascular disease is 736 per 100,000 per year (16), the prevalence of hypertension 48% (17), and the incidence of hip fracture 307 per 100,000 in men and 505 per 100,000 in women (18). It is unknown whether the main cause of dementia in this population is Alzheimer’s disease or cerebrovascular disease. If the latter cause is more important, then all measures to reduce the incidence of stroke, whether primary or secondary, will have an impact on the disability burden due to both diseases. These include control of hypertension, diabetes and use of anti-platelet agents or anticoagulants. Currently population control of hypertension is unsatisfactory, as only approximately half of the subjects with hypertension have been diagnosed, and of those with known hypertension, only about half have adequate control (17). The salt intake of the population is also high, approximately 80% having intakes of >100 mmol/day (J. Woo, S. Leung, & S.C. Ho, unpublished results). Therefore public health measures to improve detection and dietary alteration may be important. The prevalence of diabetes is also high, the age-adjusted prevalence being 7.5% (19). Again public health measures such as screening and lifestyle alterations may be beneficial. For fractures, measures to reduce bone loss (for those in middle age), to increase peak bone mass (in the young), and to reduce the incidence of falls (in the elderly patients), will be important.

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