The prevalence of falling and status of physical function among elderly individuals with locomotive and visual/hearing disorders

Original Article

Title:

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Abstract

In a super-aged society, the need for prevention of locomotor dysfunction is growing, and evidence for feasible preventive measures is thus required. This study aimed to examine the relationship between these disorders and the prevalence rates for falling and physical function status. Participants included 1182 community-dwelling elderly Japanese individuals aged 60 and older. Subjects were classified into four groups on the basis of the presence or absence of locomotive and visual/hearing disorders. Locomotive and visual/hearing organs disorders and physical function were assessed using a self-rated questionnaire. Competence level with activities of daily living (ADL) was used to assess physical function. Locomotive disorder was more prevalent in females than in males, and the presence of such disorders tended to have more influence on the risk of falling and decline in ADL function in females than in males. Locomotive disorders may have a greater effect on the lives of elderly females compared with elderly males. Although there was no significant odds ratio in the presence of multiple disorders, the prevalence rate of the multiple disorders increased with age and this increased the risk of falling also increases with age.

Key-Words: Locomotive disorder, visual disorder, hearing disorder, community-dwelling elderly

Introduction

Maintaining physical activity levels sufficient to preserve physical function is important to prevent falls among elderly individuals living independently in the community (American Geriatrics Society et al., 2001; Gregg et al., 2000; Liu-Ambrose et al., 2005; Lord et al., 2005; Seichi et al., 2012). Reduced locomotive function and diminished life space lead to altered physical function and an increased risk of falling (American Geriatric Society, 2001). Disorders of locomotive organs, such as bones, joints, and muscles, are detrimental to the maintenance of physical activity. The importance of locomotive organ health is becoming more recognized in a super-aged society (Nakamura, 2009, 2011). The Japanese government promotes the improvement of locomotive function in the elderly as a means of preventing geriatric syndrome or disuse syndrome (Nakamura, 2009, 2011).

Locomotive organ dysfunction is common in the elderly. In 2010, the major pathologies requiring long-term care services in Japanese elderly individuals living independently included, in descending order, cerebrovascular disorders (21.5%), dementia (15.3%), joint disorders (10.9%), and falls/fractures (10.2%). The overall percentage of problems related to the locomotive organs (21.1%) was comparable with that of problems related to cerebrovascular disorders (Ministry of Health, Labour and Welfare, 2010). Locomotive disorders must be treated in order to prevent falls among community-dwelling elderly individuals. As a background to this, “Locomotive syndrome” is a new concept and proposed by the Japanese Orthopaedic Association, referring to locomotive organ disorders for which elderly individuals are receiving care services or high-risk locomotive organ disorders for which they may soon require care services (Japan Locomotive syndrome Research, 2009: Nakamura, 2009, 2011). As the elderly population in Japan increases, the need for prevention of locomotor dysfunction

is growing, and evidence for feasible preventive measures is thus required (Otani et al., 2012).

Visual and hearing disorders, which increase with aging, are also risk factors related to locomotion. For example, decreased vision compromises the ability to perceive obstacle height, maintain one-leg standing time, and walk safely. Uneven surfaces present an increased risk of falling in elderly individuals with visual disturbances. Hearing loss increases feelings of fear, reduces the ability to participate in various outdoor activities, and diminishes life space. Visual and hearing disorders are thus important risk factors for falling (American Geriatric Society, 2001). Furthermore, physical activity levels decline in elderly individuals with visual and hearing disorders, leading to decreased physical function even in individuals without active disease in the locomotive organs.

Therefore, healthy locomotive and visual/hearing organs are important to prevent falls among community-dwelling elderly individuals and maintain high levels of physical activity. However, the incidence of locomotive and visual/hearing disorders and the multiple influences of these disorders on falling risk and physical function status have not been adequately determined. Hazard ratios for falling may differ according to the number of disorders, and physical function may differ among groups of elderly individuals with different combinations of these disorders. Examination of these relationships may provide useful information that may facilitate the development of countermeasures for the prevention of falls among community-dwelling elderly individuals.

This study aimed to determine the prevalence rates of locomotive and visual/hearing organs disorders among Japanese elderly individuals living independently in the community and examine the relationships between these

disorders and the prevalence rates for falling and physical function status in this population.

Methods

Participants

A total of 1530 independent community-dwelling elderly individuals were recruited from Ishikawa, Fukui, Aichi, and Oita Prefectures in Japan. A questionnaire that included questions related to fall experience, locomotive organ impairment, fall risk, and ADL competence was then administered to all participants. The response rate was 85% (1296/1530). Participants who provided incomplete responses were excluded, and 1182 respondents (77%) were eventually subjected to statistical analysis. They included 278 males (73.3 ± 7.2 yr) and 904 females (73.1 ± 7.1 years), of which 272 (23.0%) had experienced a fall in the previous 12 months. A written explanation of the purpose of this study was provided, and informed consent was obtained in writing from each subject. This study was approved by the Ethics Committee on Human Experimentation of Faculty of Human Science, Kanazawa University.

Assessment of fall experience

Participants were asked to rate their experiences of falling in the previous 12 months, and they were classified as fallers and nonfallers on the basis of their response to this question.

Assessment of locomotive and visual/hearing organs disorder

Participants were asked to rate their health status in terms of locomotive and visual/hearing organs, and their physical function status. Participants were

questioned whether they had any joint or musculoskeletal disorders (pain, complaints, diseases, disabilities) in the locomotive organs (feet, ankle, knees, hips) and trunk and were instructed to answer as yes or no for each site. The participants self assessed the status of their locomotive organ health. Disorders of the visual and hearing organs were also investigated. This study identified an individual to have locomotive impairments if he/she was symptomatic or had a disorder involving any of the abovementioned sites.

The study sample was divided into four groups on the basis of the presence or absence of locomotive and visual/hearing disorders: subjects with no locomotive or visual/hearing disorders (no disorder group), subjects with only visual/hearing disorders (visual/hearing disorder group), subjects with only locomotive disorders (locomotive disorder group), and subjects with both locomotive and visual/hearing disorders (multiple disorder group). Sample size and mean age of subjects in each group are shown in Tables 1 and 3, respectively.

Assessment of ADL competence

To evaluate physical function, the activities of daily living (ADL) assessment sheet approved by the Ministry of Education, Culture, Sports, Science and Technology in Japan was used (Ministry of Education, Culture, Sports, Science and Technology, 1999. This ADL assessment sheet comprises 12 items representing four domains concerning locomotive activities (five items), manual activities (two items), balancing activities (three items), and posture-changing activities (two items). Each item is graded on a 3-point scale, and scores are combined to produce total (minimum 12, maximum 36) and subscale scores. Higher scores are thus associated with better physical function.

Statistical Analyses

To determine the prevalence rates of locomotive and visual/hearing disorders and the prevalence rate for falling among the elderly individuals with these disorders, the prevalence rate for falling was calculated by sex and disorder group. The odds ratio of falling in each group was calculated on the basis of the values obtained for the no disorder group. Furthermore, logistic regression analysis, which used fall experience as a dependent variable and used sex, age, locomotive disorder and visual/hearing disorder as independent variables, was conducted to confirm the odds adjusting the effects of sex and age.

To compare the distribution characteristics of ADL scores among groups, a frequency distribution was converted to a cumulative relative frequency distribution curve for each group. Among the groups with different physical function levels based on ADL competence, their cumulative relative frequency distribution curves were positioned to either side. For example, the distribution curve of a group with high ADL competence tends to position on the right side (high-score area), whereas that of a low ADL competence group tends to position on the left side (low score area). Analysis of covariance (ANCOVA) was used to assess the effects of the disorders and sex on physical function (ADL score) because of the significant difference in mean age between groups. The significance level in this study was set at 0.05. STATISTICA 06J (StatSoft Japan, Tokyo, Japan) was used for performing statistical analysis.

Results

Risk of falling in each group

Table 2 shows the prevalence rates and odds ratios for falling in each group. In the sample as a whole, the prevalence rate for falling in the multiple disorder group

(32.4%) was roughly twice that in the no disorder group (16.8%). In the entire sample, the odds ratio for falling (risk of falling) was 2.4 (95%CI: 1.59 – 3.52). With regard to male elderly subjects, the prevalence rate for falling in the multiple disorder group was roughly twice that in the no disorder group, and the odds ratio was 2.9 (95%CI: 1.31 – 6.58) for this group. No acute increase in the risk of falling was observed in subjects in the other two groups (odds ratios in the visual/hearing disorder group was 1.1 (95%CI: 0.47 – 2.02) and locomotive disorder group were both 1.1 (95%CI: 0.58 – 2.13)). In contrast, in female elderly subjects, the risk of falling showed a tendency to increase depending on the disorder: visual/hearing disorders (odds ratio, 1.6 (95%CI: 0.75 – 3.44)), locomotive disorders (odds ratio, 2.1 (95%CI: 1.40 – 3.02)), and multiple disorders (odds ratio, 2.5 (95%CI: 1.54 – 3.92)). The influence of locomotive disorders on the risk of falling was greater than that of visual/hearing disorders, and the risk of falling because of locomotive disorders was comparable with that because of multiple disorders.

Table 3 shows the result of Logistic regression analysis (dependent variable: fall experience; independent variables: sex, age, locomotive disorder, visual/hearing disorder, and multiple disorders). In the total sample, significant odds ratio was found in locomotive disorder (odds ratio = 1.6; 95%CI: 1.1 – 2.5), but not in other independent variables. Although significant odds ratio in locomotive disorder was also found in females (odds ratio = 1.8; 95%CI: 1.1 – 3.1) but not in males. There were no significant odds ratios in other independent variables.

Physical function status in each group

Figure 1 shows the cumulative relative frequency distribution curves for each sex and disorder groups. The distribution curves in both of male and female groups positioned

in the most right side (high score area), and then shifted to left side (low score area) in order of the visual/hearing disorder group, locomotive disorder group, and multiple disorder group. Except the visual/hearing disorder group, distribution curves of males positioned in right side compared with those of females. In male elderly, the curve of the no disorder group positioned in right side and the curves of other disorder groups positioned in left side comparing the curve of the total group. In contrast in female elderly, the curves of no disorder and visual/hearing disorder groups positioned in right side and those of locomotive and multiple disorder groups positioned in left side. Similar trends were found in other ADL competences.

Table 4 shows the results of analyzing sex and disorder-specific differences in mean age and ADL scores. Significant differences in mean age were observed between groups; mean age was significantly higher in the multiple disorder group, followed by the locomotive disorder and visual/hearing disorder groups and the no disorder group. No significant difference was observed between the visual/hearing and locomotive disorder groups.

Regarding total ADL score, significant interactions were found and significant sex differences were observed between the no disorder and locomotive disorder groups. In male subjects, total ADL scores were significantly higher in the single and multiple disorder groups than in the no disorder group. However, no significant differences were observed between the locomotive disorder, visual/hearing disorder, and multiple disorder groups. With regard to female subjects, total ADL scores for those with locomotive disorders or multiple disorders were lower than total ADL scores for those with only visual/hearing disorders or no disorders. A similar trend was found in ADL scores for locomotive activity.

Significant interactions were found between ADL scores for locomotive and

manual activities. As with the total ADL score, a significant difference in locomotive activity score was observed between groups. With regard to the male subjects, locomotive activity scores for the no disorder group were higher than those for the single and multiple disorder groups. No significant differences were observed between the visual/hearing, locomotive, and multiple disorder groups. With regard to female subjects, however, locomotive activity scores for the locomotive and multiple disorder groups were lower than those for the visual/hearing and no disorder groups. No significant differences between sexes were observed in the ADL scores for balancing activities, which were the highest in the no disorder group, followed by the visual/hearing disorder, locomotive disorder, and multiple disorder groups; these differences were statistically significant. However, significant sex differences were found in ADL scores for posture-changing activities; scores for males were significantly higher than those for females. Posture-changing activity scores in the no disorder and visual/hearing disorder groups were significantly higher than those in the locomotive and multiple disorder groups.

Discussion

Differences in mean age between the four groups in this study suggest that the risk of locomotive and visual/hearing disorders increases with age even for elderly individuals living independently in the community. The risk of having multiple disorders also increases with aging. Physical activity in daily living must be promoted in this population in order to maintain high physical function levels and prevent falls (Liu-Ambrose et al., 2005; Lord et al., 2005). Although in this study, 27% subjects aged ≥75 years (males: 35.8%, females: 24.3%) had no disorders, approximately 43% (males: 31.7%, females: 47.4%) had locomotive disorders and approximately 23% (males: 20.3%,

females: 23.8%) had multiple disorders. The prevalence of locomotive disorders was higher in females than in males. These age- and sex-specific differences influence the risk of injury. In planning countermeasures, these statistics regarding locomotive and visual/hearing disorders in community-dwelling elderly individuals must be considered.

Analyses of the relationship between the disorders and the prevalence rate for falling revealed that the risk of falling in subjects with both locomotive and visual/hearing disorders is 2.5–3 times that in subjects with no disorders (Table 2). However, when considering the effects of sex, age and other disorders, significant odds ratio was only found in the locomotive disorder and this trend was only found in the female elderly (Table 3). The results of this study suggest that the contribution to the risk of falling is greater in the locomotive disorder than other disorders, and this trend differs between males and females; the increase in the risk of falling because of locomotive disorders was greater in female than in male subjects. In contrast, it is unlikely that holding the visual/hearing disorders or both of locomotive and visual/hearing disorders have a positive effect on the risk of falling. Considering the fact that risk of single or multiple presence of these disorders increases and physical function decrease in the old-old, there is no doubt that the risk of falling increases with age.

This study also demonstrated that having a locomotive or visual/hearing disorder results in a decline in ADL. Because the sample examined here included community-dwelling elderly individuals living independently, ADL scores were relatively high. The fact that differences in ADL scores were found for elderly subjects with relatively higher physical function indicates the strong influence of locomotive and visual/hearing disorders on the decline in ADL.

Significant interactions between groups and sex were found in terms of ADL scores for locomotive ability. Scores for male subjects with any kind of disorder were lower than those for male subjects with no disorder. In contrast, no significant differences were observed between scores for female subjects in the no disorder group and those for female subjects in the visual/hearing disorder group. ADL scores for locomotive ability in these two groups were higher than those in female subjects with locomotive disorders, including those with multiple disorders. Therefore, locomotive disorders were closely related to lower scores for locomotive ability on the ADL assessment sheet for females compared with males.

Osteoporosis and osteoarthritis were known as representative locomotive disorders. Yoshimura et al. (2009) reported that although the prevalence rates of osteoarthritis of the knee or lumbar spine increased with age in both male and female Japanese elderly individuals, the prevalence rates of osteoarthritis of the knee increased more in female elderly individuals aged ≥75 years (sex differences tended to increase as well). High prevalence rates for osteoarthritis of the lumbar spine have been observed in middle-aged males. Although this trend continues in old age, sex differences tend to decline. Prevalence rates for osteoporosis of the lumbar spine or femoral neck strongly increase with age in elderly females, who are also more likely to have a fear of falling (Scheffer et al., 2008). Therefore, when elderly females suffer from locomotive disorders, including bone fragility, their fear of falling may increase; consequently, their physical activity may decrease and result in a decline in their locomotive function. The results obtained in this study indicated an interaction between locomotive function (as indicated by ADL scores) and the risk of falling in female elderly subjects, which was strongly influenced by the presence or absence of locomotive disorders. Considering the high prevalence rates of locomotive disorders

(Table 1) and the consequent increase in the risk of falling (Table 2), especially in elderly females, awareness of maintaining healthy locomotive organs is essential to promote appropriate countermeasures and prevent falls in community-dwelling elderly individuals.

This study focused on the influence of locomotive and visual/hearing disorders on the risk of falling and ADL function. However, a cross-sectional design was used and disorders were self-rated; therefore, a subjective bias may be present. The results obtained in this study can be generalized within the methodological limitation. A more strictly controlled study design involving a control group is required. In addition, defining disorders on the basis of a medical diagnosis made by a specialist may be required to determine the influence of locomotive and visual/hearing disorders on the risk of falling and physical function status in elderly people. Furthermore, inclusion of a larger number of male elderly participants is required in future studies to determine the factors influencing sex differences.

Conclusions

This study examined the relationships between locomotive and visual/hearing disorders and the risk of falling and ADL function in community-dwelling elderly individuals in Japan. The influence to the risk of falling was grater in the presence of only a locomotive disorder than other disorders. This trend differed between the male and female elderly, the increase in the risk of falling because of locomotive disorders was greater in female than in male subjects. Although there was no significant odds ratio in the presence of multiple disorders, the prevalence rate of the multiple disorders increases with age, and the risk of falling increases with age. Having multiple disorders or locomotive disorder had a significant effect on physical function,

and this trend was more prevalent in females than in males.

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Conflict of interest statement

All authors declare that they have no competing interests.

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Table 1 Sample size in each group

	Taotal				Males				Females			
	Aged <75 years		Aged ≥75 years		Aged <75 years		Aged ≥75 years		Aged <75 years		Aged ≥75 years	
	n	%	n	%	n	%	n	%	n	%	n	%
Non disorder	326	48.2	137	27.1	86	55.5	44	35.8	240	46.0	93	24.3
Visual/hearing disorder	51	7.5	32	6.3	21	13.5	15	12.2	30	5.7	17	4.5
Locomotive disorder	237	35.0	220	43.6	41	26.5	39	31.7	196	37.5	181	47.4
Multiple disorder	63	9.3	116	23.0	7	4.5	25	20.3	56	10.7	91	23.8
Total	677		505		155		123		522		382	

Table 2 The prevalence rates and odds ratios for falling in each group

	Total				Males				Females			
	Sample size	Number of Fallers	Fall prevalence rate (%)	Odds ratio (95%CI)	Sample size	Number of Fallers	Fall prevalence rate (%)	Odds ratio (95%CI)	Sample size	Number of Fallers	Fall prevalence rate (%)	Odds ratio (95%CI)
Non disorder	463	78	16.8		130	30	23.1		333	48	14.4	
Visual/hearing disorder	83	19	22.9	1.5	36	9	25.0	1.1	47	10	21.3	1.6
				(0.8 - 2.6)				(0.5 - 2.6)				(0.8 - 3.4)
Locomotive disorder	457	117	25.6	1.7*	80	20	25.0	1.1	377	97	25.7	2.1*
				(1.2 - 2.3)				(0.6 - 2.1)				(1.4 - 3.0)
Multiple disorder	179	58	32.4	2.4*	32	15	46.9	2.9*	147	43	29.3	2.5*
				(1.6 - 3.5)				(1.3 - 6.6)				(1.5 - 3.9)

*: $p < 0.05$

Table 3 The results of logistic regression analysis

	Independent variables	B	SE	Wald	df	p	Odds ratio	95%CI	
Total sample	Sex	-0.36	0.21	3.00	1	0.08	0.7	0.5	1.0
	Age	0.01	0.01	0.58	1	0.45	1.0	1.0	1.0
	Locomotive disorder	0.50	0.22	5.08	1	0.02	1.6*	1.1	2.5
	Visual/hearing disorder	0.02	0.21	0.01	1	0.92	1.0	0.7	1.5
	Multiple disorders	0.46	0.47	0.97	1	0.32	1.6	0.6	4.0
		-2.46	1.03	5.69	1	0.02	0.1		
Males									
	Age	0.01	0.03	0.31	1	0.58	1.0	1.0	1.1
	Locomotive disorder	0.17	0.43	0.15	1	0.70	1.2	0.5	2.8
	Visual/hearing disorder	0.10	0.28	0.13	1	0.72	1.1	0.6	1.9
	Multiple disorders	0.67	0.76	0.78	1	0.38	1.9	0.4	8.6
		-3.03	1.83	2.72	1	0.10	0.0		
Females									
	Age	0.01	0.02	0.28	1	0.60	1.0	1.0	1.0
	Locomotive disorder	0.61	0.26	5.29	1	0.02	1.8*	1.1	3.1
	Visual/hearing disorder	-0.11	0.32	0.11	1	0.74	0.9	0.5	1.7
	Multiple disorders	0.62	0.68	0.83	1	0.36	1.9	0.5	7.1
		-3.08	1.12	7.57	1	0.01	0.0		

This Table shows the results of logistic regression analysis which used fall experience as a dependent variable and sex, age, locomotive disorder, visual/hearing disorder, and multiple disorders s as independent variables. *: $p<0.05$

Table 4 The sex and disorders-specific differences in mean age and ADL scores

		A: no disorder		B: visual/hearing disorder		C: locomotive disorder		D: multiple disorder		ANCOVA			Multiple comparisons	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Sex	Disorders	Interaction		
Mean age	Males	71.3	7.0	74.1	6.8	74.0	7.6	78.2	6.0	2.1 ns	28.2 *	0.2 ns	Sex	
	Females	70.6	6.8	73.8	6.8	73.2	6.3	76.7	6.8				Disoeders	A<B,C<D
Total score	Males	30.9	4.3	26.9	6.5	26.8	5.6	24.9	4.9	16.3 *	42 *	4.1 *	Sex	A,C: Males > Females
	Females	29.3	4.5	28.2	4.5	24.1	5.3	22.9	5.2				Disoeders	Males: A>B,C,D
														Females: A,B>C,D
Locomotive activity	Males	12.9	2.0	10.9	3.1	11.1	2.6	10.2	2.4	30.4 *	31.9 *	4.4 *	Sex	A,C: Males > Females
	Females	11.8	2.4	11.3	2.2	9.4	2.7	8.9	2.6				Disoeders	Males: A>B,C,D
														Females: A,B>C,D
Manual activity	Males	5.1	0.9	4.6	1.2	4.6	1.2	4.6	0.9	3 ns	10.9 *	3 *	Sex	
	Females	5.1	0.9	4.9	0.9	4.4	1.1	4.1	1.1				Disoeders	Males: A>C
														Females: A,B>C,D
Balancing activity	Males	7.8	1.3	6.9	1.8	6.8	1.6	6.2	1.7	0.3 ns	25.9 *	1.6 ns	Sex	
	Females	7.7	1.2	7.4	1.3	6.5	1.6	6.2	1.5				Disoeders	A>B>C>D
Posture-changing activity	Males	5.1	1.0	4.5	1.3	4.3	1.3	4.0	1.2	8 *	33.3 *	2.1 ns	Sex	Males > Females
	Females	4.8	1.0	4.7	1.2	3.8	1.1	3.8	1.0				Disoeders	A,B>C,D

Note. Sex and disorder-specific difference in mean age was analyzed by two-way ANOVA. Analysis of covariance (ANCOVA) was used to assess the effects of the disorders and sex on physical function (ADL score) because of the significant difference in mean age between groups.
Sample size in each disorders groups were as follows; no disorder (male = 130, Female = 330), visual/hearing disorder (males = 36, female = 47), locomotive disorder (males = 80, females = 377), and multiple disorder (males = 32, females = 147). *: $p < 0.05$, ns: no significance

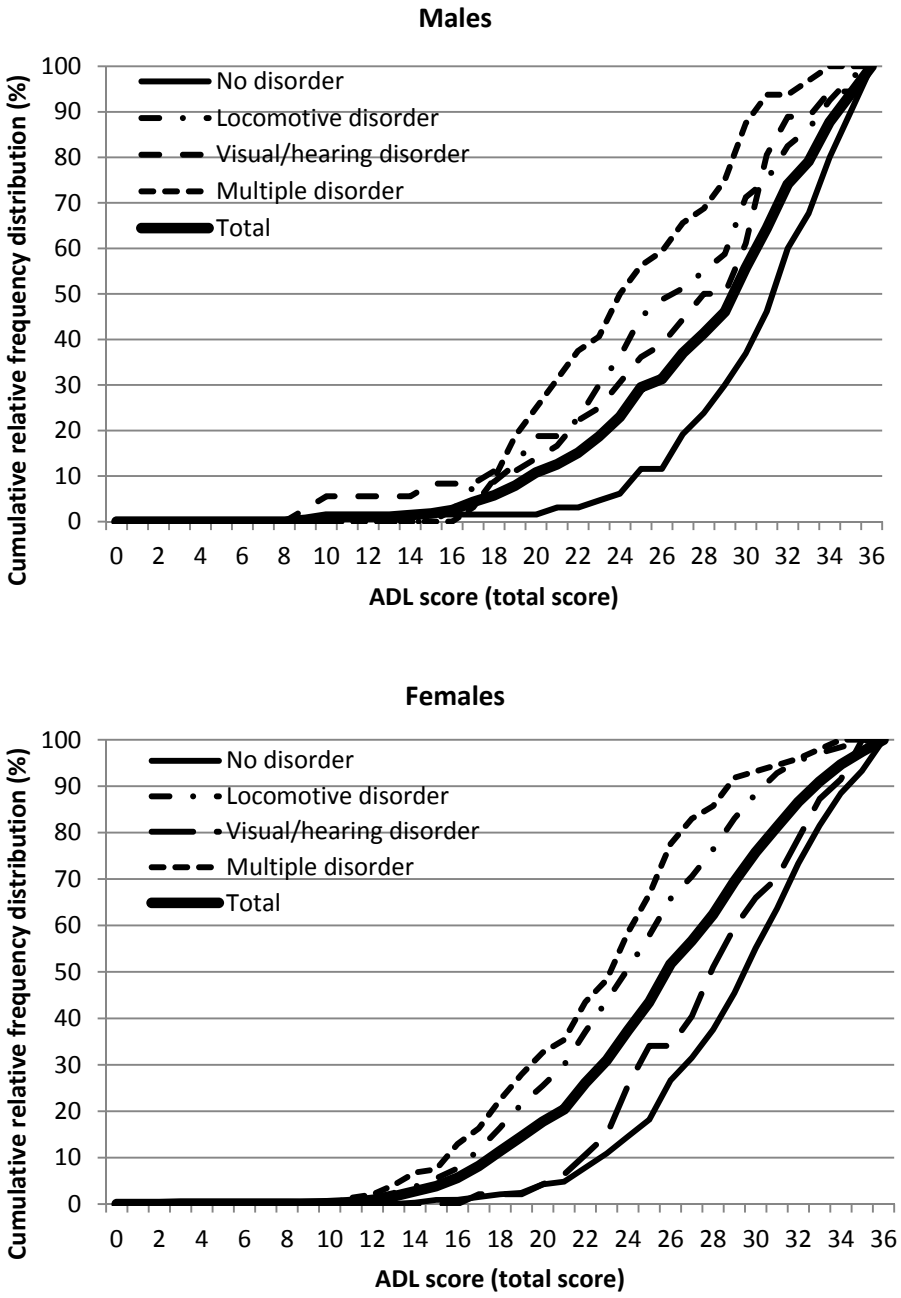

Figure 1. The cumulative relative frequency disribution curves of ADL score for each sex and disorder groups