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Instrumental Activities of Daily Living as a Potential Marker of Frailty: A Study of 7364 Community-Dwelling Elderly Women (the EPIDOS Study)

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Background. A number of clinical conditions have been shown to be associated with frailty in elderly people. We hypothesized that incapacities on the Instrumental Activities of Daily Living (IADLs) scale could make it possible to identify this population. We investigated the associations between IADL incapacities and the various known correlates of frailty in a cohort of community-dwelling elderly women.

Methods. Cross-sectional analysis was carried out on the data from 7364 women aged over 75 years (EPIDOS Study). The IADL was the dependent variable. Sociodemographic, medical, and psychological performance measures were obtained during an assessment visit. Falls in the previous 6 months and fear of falling were also ascertained. Body composition was measured by dual-energy x-ray absorptiometry. The factors associated with disability in at least one IADL were included in a logistic regression model.

Results. Thirty-two percent of the population studied had disability in at least one IADL item. This group was significantly older (81.7 ± 4.1 yr vs 79.8 ± 3.4 yr), had more frequent histories of heart disease, stroke, depression or diabetes, and was socially less active ($p = .001$). These associations persisted after multivariate analysis. Cognitive impairment as assessed by the Pfeiffer test (Pfeiffer score <8) was closely associated with disabilities on the IADL (OR 3.101, 95% confidence interval [CI] 2.19–4.38). Falls and fear of falling were also more frequent in the group of women with an abnormal IADL ($p = .001$) but only fear of falling remained significantly associated with incapacities on at least one IADL item after logistic regression (OR 1.47, 95% CI 1.28–1.69). Women with disability on at least one IADL item also had lower bone mineral density, this was independent of the other factors.

Conclusion. Our results confirmed that women with disability on at least one IADL item are frailer because they had more associated disorders, poorer cognitive function and more frequent falls. Disabilities on this scale could be a good tool for identifying individuals at risk of frailty among elderly persons living at home and in apparent good health. This finding requires confirmation by longitudinal studies.

THE heterogeneity of the elderly population is a well-established notion (1). Identification and management of the factors explaining this heterogeneity, and above all, those factors associated with functional decline and dependence, are among the essential objectives of geriatrics.

During recent years, there have been an increasing number of publications dealing with frailty in elderly persons (2). Frailty corresponds to a combination of deficits or conditions that arise with increasing age and contribute to making the elderly person more vulnerable to changes in the surroundings and to stress (3–5). Verdery (6) suggests that "failure to thrive" is a syndrome that occurs in the elderly subject and corresponds to the terminal, irreversible stage of frailty. It seems evident that targeted interventions would be more effective if they were initiated before the loss of autonomy.

The definition and evaluation of frailty in the literature are somewhat vague and have evolved progressively over time. Stamford (7) used this term for institutionalized patients. Other authors consider that frailty, like disability, can be measured by the change in ability to perform the basic activities of daily living (ADLs) (8,9). For Strawbridge (10), the concept of frailty corresponds to functional loss in at least two of the following domains: physical and nutritional status, cognitive function, and sensory function. Even if frailty and disability are often associated, two different entities are involved. Frailty, unlike disability, refers to an unstable state with a risk of functional loss (5). Campbell emphasizes the interaction of the individual with his or her environment, in which the occurrence of a minor event may tip the balance toward disability and loss of autonomy.

A certain number of clinical conditions have been shown to be associated with frailty and the onset of functional decline. Among these are nutritional problems such as excess weight (11,12) or significant weight loss (13), restricted mobility (14), a history of falls (15), and cognitive impairment (16). Body composition and in particular the onset of sarcopenia (17) and decreased bone mineral density (18) also seem to contribute to the risk of functional decline.

Because frailty is a potentially reversible state, it is important to determine the screening tool or tools that will identify persons at risk. This would make it possible to rapidly initiate adequate intervention programs.

In this study, we investigated the associations between instrumental abilities of daily living as measured by the Instrumental Activities of Daily Living (IADL) scale (19) and the various known correlates of frailty. We took into account the sociodemographic and medical characteristics and body composition in a population of elderly women living at home who had taken part in the EPIDOS study, a French prospective multicenter study on risk factors for femoral neck fractures.

We hypothesized that disabilities on the IADL scale could make it possible to identify a subgroup of elderly persons presenting the characteristics of frailty. We chose disabilities in scale items IADLs as the dependent variable because, in general, disabilities in IADLs precede disabilities in the ADLs and loss of autonomy. The IADL scale is also a simple and rapid tool for evaluating elderly subjects and has previously been widely validated in various populations on individual and epidemiological levels (20–22).

Subjects and Methods

Subjects

The original EPIDOS cohort was composed of 7575 women aged over 75 years recruited between 1992 and 1994 from electoral rolls (23). Women with a history of femoral neck fracture or hip replacement and those living in nursing homes were excluded. To take part in the study, they had to be well and able to understand and reply to the questionnaires. The ethics committee approved the study, and each woman signed an informed consent form.

Measurements

This study was based on data collected during the initial visit. These data formed the cross-sectional part of the investigation and included the results from a questionnaire, a clinical examination, and measurement of body composition.

The questionnaire dealt with social and demographic data: age in years, place of residence and living arrangements (alone at home, at home with another person, or in a senior citizens' housing unit), and educational level assessed by a dichotomous variable indicating receipt of the French certificate of elementary education (generally obtained at the age of about 14 years). Income was classified in the following brackets: less than $500 (equivalent to 3000 Fr) per month, from $500 to $1000 (3000–6000 Fr) per month, and over $1000 (6000 Fr) per month. Persons with an income of over $1000 per month were used as reference for the analysis. Because in many cases it was not possible to ascertain income, we created an "income unknown" category. Last, the social activities of the women were noted (e.g., daily visits, vacations, or participation in a senior citizens' club).

Physical autonomy was evaluated by three ADL items (washing, dressing, and walking) and by the IADL scale: eight items assessing ability to travel, shop for groceries, prepare meals, do housework, launder clothes, use the telephone, take medications, and manage money. Cognitive function was evaluated using Pfeiffer's test (24). Falls in the six months before the study and their consequences, in particular psychological (fear of falling), were addressed by specific questions. We assessed self-rated health by asking the women how they perceived their own state of health as compared with women of the same age (equally good, better, or less good).

Finally, weight (kg) and height (cm) were measured for each subject, and the body mass index (BMI) was calculated using the formula weight/height^2. Whole body composition was assessed by dual-energy x-ray absorptiometry (DEXA, Lunar-DPX-Plus, Madison, WI).

Statistical Methods

Bivariate analysis was carried out to seek factors associated with IADL disability, using standard tests such as the chi-square test or Fisher's exact test for categorical variables and Student's *t* test or nonparametric tests for quantitative variables.

Logistic regression was performed to account for confounding factors and to identify the impact of individual factors. The dependant variable was disability on the IADL items and was coded 0 if there was no disability and 1 if the subject had at least one disability.

All variables related to the threshold of 25% disability on the IADL scale after bivariate analysis were included in the model, and descending stepwise regression was used to select the variables associated with disabilities in the IADLs.

Results

The data of 7364 women were analyzed. Among them, 5003 (67.9%) were totally independent for IADL, while 15.3% ($n = 1130$) and 7.3% ($n = 540$) had disabilities on one or two IADL items, respectively. Six hundred ninety-one (9.5%) of the women had disabilities on more than two IADL items.

Table 1 summarizes the sociodemographic and medical characteristics of the women according to their degree of disability on the IADL scale. Women who were totally independent for IADLs were significantly younger (79.8 $\pm$ 3.4 years vs 81.7 $\pm$ 4.1 years; $p = .0001$) and had fewer previous disorders, in particular cardiac or neurological disorders. Falls in the six months preceding the study were also more frequent in women with at least one IADL disability (26.0% vs 22.8%; $p = .0033$). This was also true of the fear of falling, which was more frequent if there was disability on at least one IADL item (65.1% vs 44.8%; $p = .0001$). There was also a definite link between previous falls and fear of falling: 59.9% of women who had already had a fall expressed fear compared with 48.7% of those who had not ($p = .001$).

Not all instrumental activities of daily living were equally affected. The item most frequently cited was use of transportation (17.3%) followed by items related to management of money (14.1%), housework (13.1%), shopping (10.4%), washing (8.5%), cooking (2.8%), managing medications (1.9%), and using the telephone (1.2%). Table 2 shows the characteristics of body composition according to the IADL score. Women with total autonomy on the IADL scale had lower body weight and BMI than the others, and their bone mineral density (BMD) was also significantly higher. Table 3 summarizes the Pearson correlation coefficients between the various parameters. Only fat mass and BMD were intro-

Table 1. Comparison of the Various Groups According to the Number of Disabilities on the IADL Scale in 7364 Community-Dwelling Elderly Women

	0 IADL Disabilities (n = 5003)	1 IADL Disability (n = 1130)	2 IADL Disabilities (n = 540)	≥3 IADL Disabilities (n = 691)	p Value
Age (y)	79.9 ± 3.4	81.0 ± 3.7	81.7 ± 4.2	82.7 ± 4.3	.0001
Marital Status (%)					
Unmarried	539 (11.0)	72 (6.5)	42 (8.0)	41 (6.0)	.0001
Married	1287 (26.0)	288 (25.5)	122 (22.5)	161 (23.5)	
Divorced	351 (7.0)	50 (4.5)	33 (6.0)	30 (4.5)	
Widowed	2824 (56.0)	720 (63.5)	343 (63.5)	458 (66.0)	
Certificate of Elementary Education (%)	4243 (85.0)	779 (69.0)	359 (66.5)	424 (61.5)	.001
Monthly Income (%)					
Unknown	479 (9.5)	97 (8.5)	44 (8.0)	57 (8.5)	.001
<500 USD	310 (6.5)	145 (13.0)	101 (18.5)	135 (19.5)	
500–1000 USD	1690 (33.5)	486 (43.0)	231 (43.0)	298 (43.0)	
>1000 USD	2524 (50.5)	402 (35.5)	164 (30.5)	201 (29.0)	
Social Activities (%)					
Visits	1530 (30.5)	470 (42.0)	227 (42.5)	369 (53.5)	.001
Holidays	3699 (74.0)	589 (52.0)	258 (48.0)	218 (31.5)	
Senior citizens club	2305 (46.0)	442 (39.0)	180 (33.5)	166 (24.0)	
Medical History (%)					
Heart disease	757 (15.0)	269 (24.0)	143 (26.5)	206 (30.0)	.001
Arterial hypertension	2280 (45.5)	572 (50.9)	298 (55.5)	392 (57.0)	.001
Stroke	155 (3.0)	75 (6.5)	47 (8.5)	87 (12.5)	.001
Diabetes	233 (4.5)	94 (8.5)	47 (8.5)	71 (10.5)	.001
Parkinson	78 (1.5)	22 (2.0)	19 (3.5)	45 (6.5)	.001
Depression	582 (11.5)	202 (18.0)	97 (18.0)	180 (26.0)	.001
Vision problems	1564 (32.5)	518 (46.0)	286 (53.0)	462 (67.0)	.001
Hearing problems	2361 (47.0)	595 (52.5)	300 (56.0)	411 (59.5)	.001
Self-Rated Health/Women of Same Age (%)					
Better	1778 (35.5)	293 (26.0)	123 (23.0)	87 (12.5)	.001
Equivalent	2906 (58.0)	705 (63.0)	326 (60.5)	418 (60.5)	
Less Good	118 (2.5)	99 (9.0)	71 (13.0)	161 (23.5)	
Basic Functions (%)					
Difficulties in walking	1774 (35.5)	719 (63.5)	410 (76.0)	576 (83.5)	.001
Difficulties in dressing	20 (0.5)	8 (0.5)	14 (2.5)	97 (14.0)	.001
Difficulties in washing	15 (0.5)	15 (1.5)	18 (3.5)	125 (18.0)	.001
Falls (%)					
Falls in 6 preceding months	1141 (23.0)	269 (24.0)	141 (26.0)	202 (29.0)	.001
Fear of falling	2242 (45.0)	655 (58.0)	361 (67.0)	519 (75.5)	.001
Cognitive Function					
Pfeiffer test <8 (%)	308 (6.0)	152 (13.5)	83 (15.5)	190 (27.5)	.001

Note: IADL = instrumental activity of daily living.

duced into the logistic regression model due to the strong correlation between all body composition variables.

Logistic regression analysis showed a positive association between disability on at least one IADL item and age, memory impairment assessed by the Pfeiffer test, sensory deficits, poor self-rated health, and low income (Table 4). Histories of depression, diabetes, stroke with sequelae, and ischemic heart disease were also associated with disability on at least one IADL item. On the other hand, educational level (having obtained a certificate of elementary education) and social activities, such as participation in a senior citizens club or going on vacation, were inversely associated with disabilities on the IADL. Finally, increased bone mineral density appeared to be inversely associated with dis-

Table 2. Comparison of Body Composition According to the Number of Disabilities on the IADL Scale

	n	0 IADL Disabilities	1 IADL Disability	2 IADL Disabilities	≥3 IADL Disabilities	p Value
Weight (kg)	7360	59.4 ± 9.9	61.0 ± 11.0	61.1 ± 11.2	61.1 ± 12.3	.0001
BMI (kg/m^2)	7360	25.0 ± 3.9	26.0 ± 4.4	26.2 ± 4.6	26.6 ± 5.2	.0001
BMD (g/cm^2)	6970	0.97 ± 0.09	0.97 ± 0.10	0.95 ± 0.10	0.96 ± 0.11	.0004
Lean mass (kg)	6967	35.1 ± 3.9	35.2 ± 4.0	35.2 ± 4.3	35.4 ± 4.3	.4995
Fat mass (kg)	6969	21.6 ± 7.4	22.8 ± 8.2	22.6 ± 8.0	22.9 ± 9.4	.0001

Note: BMI = body mass index; BMD = bone mineral density; IADL= instrumental activity of daily living.

Table 3. Pearson's Correlation Between Measures of Body Composition

	Weight	BMI	Fat Mass	Lean Mass	BMD
Weight	–	0.89	0.92	0.67	0.51
BMI	–	–	0.90	0.44	0.43
Fat mass	–	–	–	0.38	0.48
Lean mass	–	–	–	–	0.29
BMD	–	–	–	–	–

Note: BMI = body mass index; BMD = bone mineral density.

abilities on the IADL scale (OR 0.11, 95% CI 0.04–0.25), whereas increased fat mass tended to be a risk factor (OR 1.02, 95% CI 1.01–1.03) (Table 4).

Discussion

There are a number of factors associated with frailty in elderly persons. Frailty syndrome corresponds to a combination of biological, physiological, social, and environmental changes that occur with advancing age. Early identification is important to initiate an adequate management strategy. Logically, the earlier in the downward process management is started, the more effective it will be. Frail individuals are generally identified when an event or stress such as a fall or an acute illness occurs or when dependence in the basic ADLs has already set in. We decided to study the relationship between the IADL scale and the various correlates of frailty. Autonomy on the IADL scale can be considered a requirement for a person to live at home independently. Moreover, disabilities on the IADL scale are a risk factor for morbidity and mortality in the elderly population (25–27).

Table 4. Factors Associated With Disability on at Least One IADL Item: Results of Logistic Regression

Variables	Odds Ratio	95% CI	*p* Value
Age (y)	1.136	1.115–1.159	.0001
Pfeiffer test <8	2.165	1.732–2.706	.0001
Difficulties in basic activities of daily living[†]	2.364	2.043–2.734	.0001
Vision problems	1.443	1.256–1.658	.0001
Hearing problems	1.182	1.033–1.353	.0154
Fear of falling	1.480	1.286–1.703	.0001
Self-rated health poorer/women of same age	5.035	3.677–6.895	.0001
Living in senior citizens' housing unit	1.746	1.360–2.241	.0001
Receiving daily visits	1.341	1.167–1.541	.0001
Taking holidays	0.594	0.516–0.685	.0001
Taking part in senior citzens club	0.717	0.623–0.825	.0001
Certificate of elementary education	0.567	0.482–0.667	.0001
Income <500 USD (ref: over 1000 USD)	1.669	1.316–2.116	.0001
History of depression	1.652	1.372–1.990	.0001
History of diabetes	1.543	1.181–2.018	.0015
Stroke with sequelae (ref: no stroke)	2.585	1.636–4.084	.0001
History of heart disease	1.438	1.220–1.694	.0001
Fat mass (kg)	1.021	1.010–1.031	.0001
Total BMD (g/cm2)	0.112	0.049–0.255	.0001

Note: BMD = bone mineral density; IADL = instrumental activity of daily living.

[†]Difficulties in at least one of the following activities: washing, dressing, or walking.

The social and family impact of dependence on the IADL scale is variable and may not be very marked. About 68% of our study population, with a mean age of 80 years, was totally autonomous on IADL items, a finding that is in overall agreement with the data of the literature and for North American populations in particular (28–30). In the United States, about 89% of women aged 65 to 74 years, 72% of those aged 75 to 84 years, and 38% of those aged over 85 years live at home totally independently (31). The figures in European studies differ somewhat. Rozzini and colleagues (32) found only 47.7% of subjects totally independent on the IADL scale in a population of 549 elderly subjects with a mean age of 77 years and living in a rural area in northern Italy. Béland (33) made similar findings in Spain: only 53.8% of persons aged over 65 years ($n = 1273$) and living at home were totally independent on the IADL scale. These authors suggest that these differences could be explained partly by a lower level of institutionalization and greater presence and support from families' members.

Our work reveals an association between incapacities on the IADL scale and the various factors and conditions related to frailty (cognitive function, nutritional status, and falls) in a population of elderly women living at home and in apparent good health. Need for help in the basic ADLs was closely associated with difficulties on the IADL scale and increased according to the number of disabilities. This association remained significant after multivariate analysis. It is true that, in general, dependence on the IADL scale precedes that on the ADL scale (9,33). Guralnik and colleagues carried out a five-year study of a population of subjects aged 75 to 84 years. After two years, 35% of subjects who had a disability on the IADL scale became dependent for basic ADLs or had entered an institution (9).

Like other authors (34,35), we underline the marked impact of self-rated health on the quality of aging. Moreover, frailty cannot be discussed without considering the psychosocial aspect and interaction with the environment. Women who had the certificate of elementary education, which in France at that time was obtained at the age of about 14 years, were significantly more independent. This relation persisted even when other factors were taken into account. The data of the literature concerning educational level and disability are contradictory. Unlike other studies (36,37), the cross-sectional study of Ensrud (11) found no association between the two. Concerning income, we found that women with the lowest income had a 1.6 greater risk of presenting an incapacity on the IADL scale. This is in agreement with the numerous studies that have shown poorer health in low-income populations.

A certain number of these factors can potentially be modified by interventional programs. Some factors may be personal, such as a depressive state, but others may relate to problems of the principal caregiver and living conditions at home (38,39). Other studies have previously shown an increased risk of frailty in persons who are socially isolated (34). Moreover, participation in social activities seems to reduce morbidity and promote successful aging (10,40). In our study, bivariate analysis showed a significant relationship between the various social activities and the level of disability on the IADL scale, and these results remained sig-

nificant after multivariate analysis. In fact, the frequency of visits to the elderly person's home by his or her family and friends increases with the number of disabilities in IADL items. This may well be the consequence of the onset of loss of autonomy. Our results also show a relationship between a history of depression and dependence on the IADL scale. Cho and colleagues (26), following 202 elderly persons (mean age, 81 years) who were living at home, demonstrated that depression was significantly associated with decline on the IADL scale over a three-year period. Among previous disorders, diabetes, stroke, and heart disease were associated, independently of each other, with IADL disabilities (36,37,41). Sensory deficits, in particular visual impairment and hearing impairment (11,42), are also closely linked with disabilities in IADL items. Multivariate analysis, as well as the effect of age, revealed a close association between memory impairment and disability on at least one IADL item (OR 2.16, 95% CI 1.73–2.70). These results are in agreement with those of Barberger-Gateau and colleagues (22,43) who had previously demonstrated the predictive value of IADL disabilities in the development of dementia.

Falls are a frequent phenomenon in the aging population and are also an important predictor of admission to a nursing home (44). About 24% of our population had fallen in the six months before the study. The incidence of falls increased with the degree of disability on IADL items. In a representative cohort of subjects aged over 71 years (n = 885) followed for one year, Tinetti and colleagues (44) revealed a significant and independent relationship between the occurrence of a fall and functional decline as measured by the IADL scale. There was a "dose-response" relation between falls and decline, and decline was more marked when the number of falls increased or if a fall was seriously injurious (15). One of the psychological consequences is the fear of falling, which develops in about one-third of persons who have fallen (45). In our study, about half the women were afraid of falling. After logistic regression analysis and adjustment in relation to other factors, fear of falling remained significantly associated with disabilities on the IADL scale.

Last, we found significant differences in body composition according to the level of disability. Women who were totally independent had significantly lower weight and BMI than those who were not. Weight and BMI have been reported as playing an important role in physical disability in elderly persons. Cross-sectional studies have previously shown that subjects with high weight and BMI have more disabilities than those with medium weight and BMI (11,12,46). The prospective work of Launer (47) suggested that high BMI is a risk factor for mobility disability in elderly women. However, the results of investigations of the association between weight and disability and even mortality are still contradictory. In the same study (47), weight loss and low BMI were also risk factors for disability in very old women. High weight and BMI may influence disability by different pathways, such as the effect on the joints of decreased activity and reduced musculoskeletal and functional capacity.

The study of body composition by DEXA revealed a positive correlation between fat mass and risk of disability on the IADL scale. Also, after multivariate analysis BMD remained significantly associated with dependence measured by the IADL scale. In other words, women with difficulties in IADL items are also those who have lower BMD. Visser (48) also found a strong correlation between fat mass and disability in 753 elderly subjects aged 72 to 95 years who were participating in the Framingham study. Women in the highest tertile for fat mass had an OR of 2.69 (95% CI 1.45–5) for disability compared with those in the lower tertile. Longitudinal studies have also shown that high body fat, contrary to low fat free mass, is an independent predictor of mobility-related disability (49). Most authors consider that bone mineral loss is associated with frailty syndrome (18,50). Decreased BMD and frequent falls would lead us to suppose that injuries are more frequent and more serious in such a population.

In our study, we did not observe any association between lean mass and disabilities on the IADL scale. Sarcopenia, defined as "age-related decline in lean body mass," is cited by the majority of authors as one of the components of frailty. However, we believe that loss of muscle mass occurs at a later stage of frailty. Arguably, higher fat mass and lower BMD could progressively lead to walking difficulties and more frequent falls. These factors could secondarily lead to sarcopenia through disuse.

In conclusion, our study reveals a significant association between disabilities on the IADL scale and various aspects of frailty in a population of healthy elderly women volunteers living in the community. In this population, disabilities on the IADL scale were well correlated with more frequent falls, poorer cognitive function, and lower bone mass. However, our cross-sectional study cannot establish the temporal nature of the relationships we observed. In the future, it will be interesting to verify these findings by longitudinal follow-up, because if they are confirmed, many of the factors involved could be the object of targeted interventions.

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