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# Physical Function in Older People

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## 1. Introduction

Aging is a natural process. Improved maternal and infant health, better survival in infancy, childhood and early adult life, has led to increase life expectancy of older people. As of 2008, 7% (506 million) of the world's population was aged 65 years and older, an increased of 10.4 million since 2007 (Kinsella K and Wan He 2009). The current pace of population aging varies widely. While developed countries have relatively high proportions of people aged 65 years and over, the most rapid increases in older people are in the developing world. As of 2008, 62% (313 million) of the world's population aged 65 and over lived in developing countries (Kinsella K and Wan He 2009). Many developing countries will be experiencing a sudden rise in the proportion of older people within a single generation, with far less well developed infrastructure. In contrast, most developed countries have had decades to adjust to the changing age structure and this change has been supported by relative economic prosperity.

## 2. Theories of population health change

The implications of longer life mean increased risk of poor physical function as expounded by the theories of population health change. Four theories have been proposed in discussing the consequences of increased life expectancy in older people.

The expansion of Morbidity/Disability Theory (Gruenberg EM 1977), suggests that the gain in life expectancy in older people is mainly due to technological advances and secondary prevention strategies that have extended the life of older people with disability and underlying illness. This results in living with non-fatal diseases such as vision loss, arthritis, chronic pain and other diseases of old age, therefore living longer means living with more years of disability.

The opposing theory is called the Compression of Morbidity/Disability Theory (Fries 1980; Fries 2005). He suggested that primary prevention strategies modify risk factors for

mortality that delays the age-at-onset and progression of disabling diseases. Assuming that maximum life expectancy is fixed, this will result in the time live with disability and disease being compressed into a shorter period before death.

Manton offered a third perspective called the “Dynamic Equilibrium Theory” that combines elements from both the expansion and compression theories (Manton KG 1982). Manton proposes that economic, medical and technical progress reduces mortality as well as having an influence on morbidity/disability. Decrease in mortality rates are accompanied by declines in the incidence and progression of chronic diseases. As a result, years of life gained are assumed to be achieved through a combination of postponement of disease onset, reduction in severity of disease and disease progression due to improvement in clinical management of diseases.

A recent theory takes into consideration the country’s position in the demographic transition phase (Robine Jean-Marie and Michel Jean-Pierre 2004). Their “General Theory of Population Aging” encompasses all the three previous theories and relies on a cyclical movement. Firstly, there is an increase in the survival rates of sick people supporting the “expansion of morbidity theory”. Second, medical improvements take place, slowing down the progression of chronic condition and achieving certain equilibrium with mortality decline, supporting the “dynamic equilibrium theory”. The third phase is improvement in health status and health behaviours of new cohorts of older people, supporting the “compression of morbidity theory”. Eventually there will be an emergence of very old and frail populations, which brings back to the starting point, that is, to a new “expansion of morbidity”.

### 3. The language of physical function

Before further discussion regarding the subject of physical function and its relevance, some definitions are necessary. The definition of the term “disability” and “functional limitation” in this chapter follows the Nagi Disablement Model (Nagi 1976). This model has proven useful as a language used by researchers to delineate the consequences of disease and injury at the levels of body systems, the person and society. The definition of disability encompasses various aspects; pathology, impairment, and limitation are terms that are directly associated with the concept of disability.

According to the classification scheme provided by Nagi, *impairment* refers to a loss or abnormality at the tissue, organ and body system level. At the level of the individual, Nagi uses the term *functional limitations* that represent limitations in performance of specific tasks by a person. The term *disability*, as defined by Nagi, refers to limitations in performing socially defined roles and tasks expected of an individual within a socio-cultural and physical environment. Both impairment and functional limitation involve function. However, for impairment, the reference is to the levels of tissues, organs and systems while for functional limitation, the reference is to the level of the person as a whole. In differentiating functional limitation from disability, functional limitation refers to organismic performance; in contrast disability refers to social performance.

The term physical disability is often used to refer to restrictions in the ability to perform a set of common, everyday tasks, performance of which is required for personal self care and independent living. This includes the basic activities of daily living (ADL) and instrumental activities of daily living (IADL). These are the most widely used measurements of physical

disability in the literature. Basic ADLs are self-care tasks such as bathing, dressing, grooming and eating (Fried LP and Guralnik 1997). The IADL's are tasks that are physically and cognitively more complicated and difficult but are necessary for independent living in the community such as getting groceries, preparing meals, performing everyday household chores. ADL and IADL are measures of disability that reflect how an individual's limitation interacts with the demands of the environment.

The evaluation of mobility refers to the individual's locomotor system. Mobility disability is a critical component of activities of daily living (Fried LP and Guralnik 1997). Mobility disability is defined as difficulty or dependency in functioning due to decreased walking ability, manoeuvrability and speed.

The building blocks of restrictions in performing ADLs are termed functional limitations (Guralnik and Luigi 2003). Functional limitations are measures independent of environmental influences, and may explain the changes in functional aspects of health. Functional limitation refers to restriction in physical performance of tasks required for independent living, such as walking, balancing and standing.

Physical function is a general term that reflects one's ability to perform mobility tasks, ADLs and IADLs. Throughout this chapter "poor physical function" is used as a general term to refer to physical disability, mobility disability and functional limitation.

#### 4. The disablement process

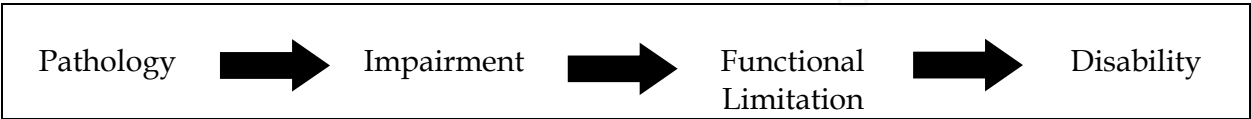
To discuss poor physical function in older people, it is important to have an understanding of the progression that ends with loss of physical function, or the disablement process. The disablement process describes how chronic and acute conditions affect functioning in specific body systems, basic human performance, and people's functioning in necessary, usual, expected, and personally desired roles in society (Verbrugge and Jette 1994). It also describes how personal and environmental factors speed up or slow down this process. There are two major models describing disability and related concepts. This chapter will describe both models. – the Nagi Model (Nagi 1976) and the International Classification of Impairments, Disabilities and Handicaps (ICIDH) (World Health Organization 1980) and its current version, the International Classification of Functioning, Disability and Health (ICF) (World Health Organization 2001) developed by the World Health Organization (WHO).

##### 4.1 The Nagi disablement model

The pathway proposed by Nagi in 1965 to describe progression from disease to disability is shown in Figure.1. Nagi's disability model is based on four related components that described the sequential steps in the theoretical pathway from disease to disability (Nagi 1976). In the Nagi pathway, *pathology* (e.g. sarcopenia) first leads to *impairment* (e.g. lower extremity weakness) (Steven M Albert and Vicki A Freedman 2010). When lower extremity weakness crosses a certain threshold, *functional limitation* (e.g. slow gait speed) becomes evident (Steven M Albert and Vicki A Freedman 2010). When this happens, a person has a *disability* (e.g. difficulty or needing help with walking across a small room).

According to this pathway, *pathology* refers to biochemical and physiological abnormalities that are medically labeled as disease, injury or congenital/developmental conditions (Ferrucci, et al. 2007; Nagi 1976; Verbrugge and Jette 1994). *Impairment* is the consequence

and degree of pathology (Nagi 1976; Verbrugge and Jette 1994). *Functional limitations* are limitations in performance at the level of the whole organism or person (Ferrucci, et al. 2007). By contrast, *disability* is defined as limitation in performance of socially defined roles and tasks within a socio-cultural and physical environment(Ferrucci, et al. 2007). Disability can also refer to the expression of functional limitation in a social context. An important advantage of utilizing different definitions for functional limitation and disability, as proposed by Nagi, is that they can be considered as sequential steps on the pathway from disease to disability. The validity of this theoretical pathway is supported by a large body of literature (Ferrucci, et al. 2007; Fried and Guralnik 1997; Steven M Albert and Vicki A Freedman 2010). Practical issues of care and prevention can be addressed by utilizing this pathway.



Source: Nagi S. An epidemiology of disability among adults in the United States. The Milbank Memorial Fund Quarterly. Health and Society. 1976; 54: 439-467

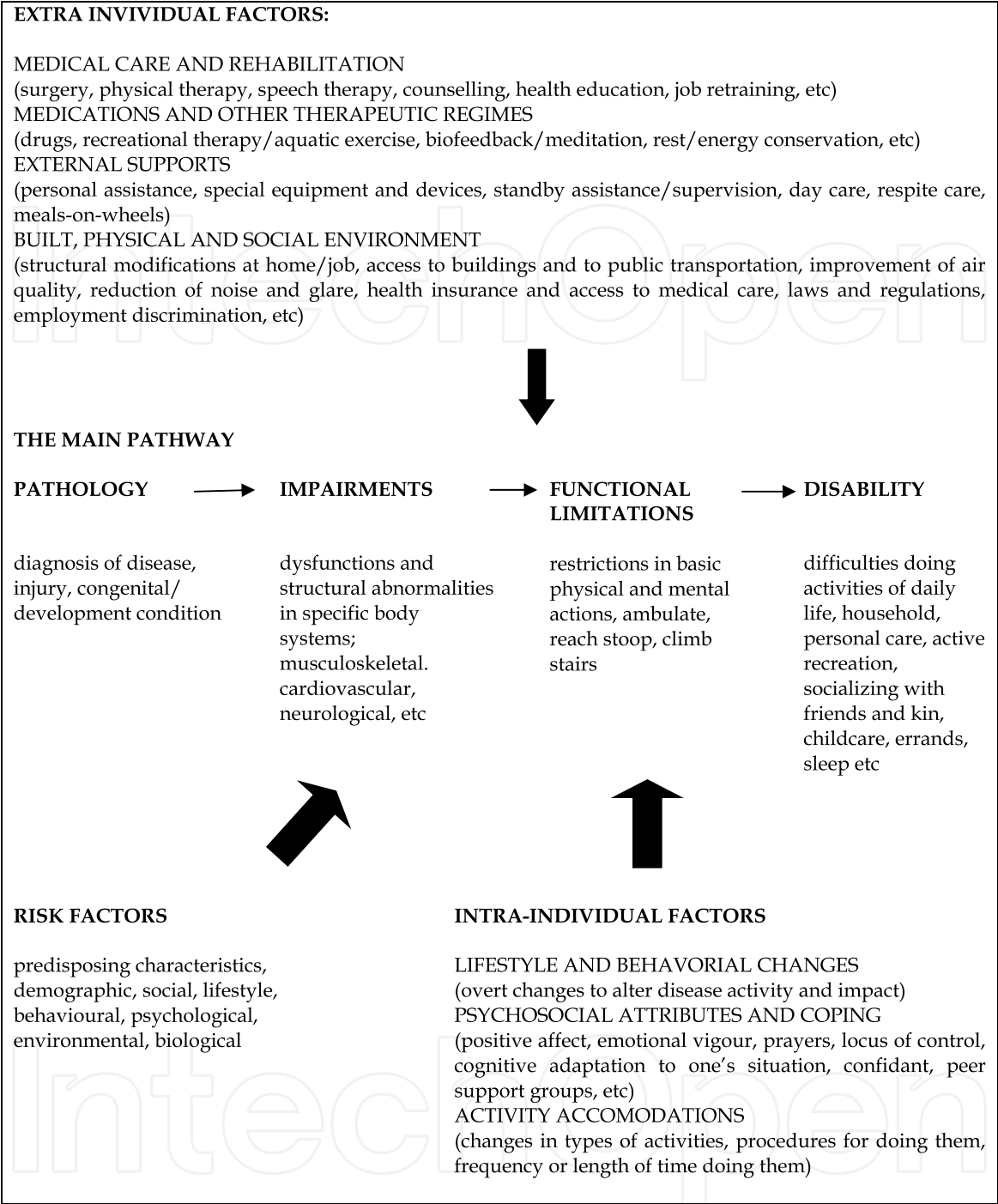
Fig. 1. Theoretical pathway from disease to disability proposed by Nagi (1965)

Nagi’s model was extended to include personal and environmental factors that influence the evolution of the disablement process (Verbrugge and Jette 1994). Verbrugge and Jette differentiate the “main pathways” of the disablement process (i.e. Nagi’s original concepts) with factors hypothesized or known to influence the ongoing process of disablement (Figure 2). This model emphasizes that predisposing risk factors, intra-individual and extra-individual factors may modify the relationship of the four components in the main pathway(Ferrucci, et al. 2007; Guralnik and Luigi 2003; Steven M Albert and Vicki A Freedman 2010; Verbrugge and Jette 1994). Risk factors are predisposing phenomena that are present prior to the onset of a disabling event that can affect the presence and/or severity of the disablement process. Intra-individual factors are those that operate within a person such as lifestyle and behavioural changes, psychosocial attributes and coping skills. Extra-individual factors are those that perform outside or external to the person. Nagi’s definition of disability and the elaboration by Verbrugge and Jette also operationalizes disability as a broad range of role behaviours that are relevant to daily activities. This includes basic ADL, IADL, paid and unpaid role activities, such as occupation, social activities and leisure activities.

4.2 World Health Organization’s models of disablement

In 1980, the World Health Organization (WHO) proposed a theoretical framework to describe the sequence from disease/disorder to impairment, disability and handicap named the International Classification of Impairments, Disabilities and Handicaps (ICIDH) (World Health Organization 1980)(Figure 3). At the foundation of the pathway is pathology, which is defined as any abnormality of macroscopic, microscopic or biochemical structure or function affecting an organ or organ system (Ferrucci, et al. 2007; Verbrugge and Jette 1994). The second step is impairment, defined as any abnormality of structure or function at the whole organism level, independent of any specific environment, symptom, or sign (Ferrucci, et al. 2007; Verbrugge and Jette 1994). At the third step is disability, which derives from the





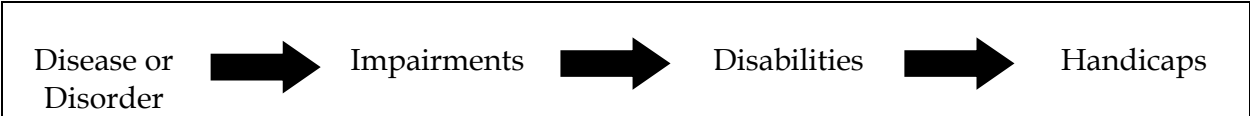
Source: Verbrugge LM, Jette AM. The disablement process. Social Science and Medicine; 1994: 38(1): 1-14

Fig. 2. The Disablement Process (1994)

interaction between the organism and the environment and is defined as any change or restriction in an individual's goal-directed behaviour (Ferrucci, et al. 2007; Verbrugge and Jette 1994). Finally, handicap is defined as any alteration in a person's status in society, including alterations in roles. Each level of the pathway should be considered as independent and may or may not be determined by the previous level and/or cause the

successive level (Ferrucci, et al. 2007; Verbrugge and Jette 1994). This approach raised criticisms for several reasons: it was thought to be too medically-orientated, ignoring social and psychological dimensions; the negative connotation of the term ‘handicap’; and the omission of environmental factors. Some of these limitations were overcome by the model proposed by Nagi.

In 2001, the WHO presented a revision of the classification under a new name called the International Classification of Functioning, Disability and Health (ICF) (World Health Organization 2001) (Figure 4). The revised model moves away from the idea that disability is a consequence of disease or aging and focuses on components of health as human functioning. The ICF has two parts, each with two components (Table 1). Part One is entitled Functioning and Disability (which includes body functions and structures, activities and participation). Part Two is entitled Contextual Factors, which includes environmental factors and personal factors.



Source: World Health Organization. International Classification of Impairments, Disabilities and Handicaps: A Manual Classification Relating to the Consequences of Diseases. Geneva. WHO, 1980.

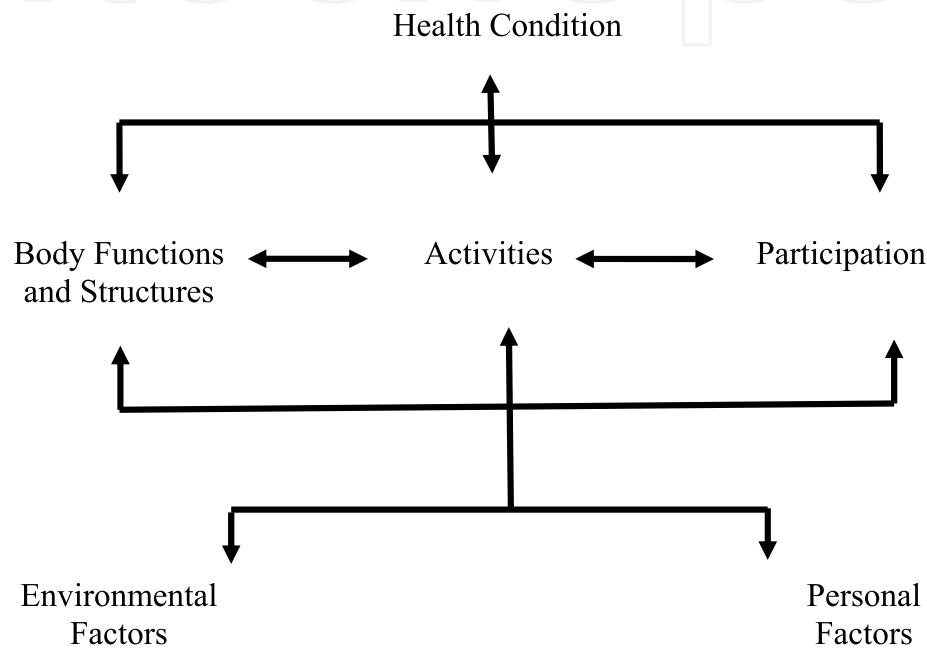
Fig. 3. The International Classification of Impairments, Disabilities and Handicaps Model (ICIDH), 1980

Component	Part 1 : Functioning and Disability		Part 2: Contextual Factors	
	Body functions and structures	Activities and participation	Environmental factors	Personal factors
Domains	Body functions Body structures	Life areas (tasks, actions)	External influences on functioning and disability	Internal influences on functioning and disability
Constructs	Change in body functions (physiological) Change in body structure (anatomical)	Capacity: executing tasks in a standard environment Performance: executing tasks in the current environment	Facilitating or hindering impact of features of the physical, social, and attitudinal world	Impact of attributes of the person
Positive aspect	Functional and structural integrity	Activities and Participation Activity limitation	Facilitators	Not applicable
Negative aspect	Impairment	Participation restriction	Barriers/hindrances	Not applicable

Source: World Health Organization. International Classification of Functioning, Disability and Health (ICF). Geneva. WHO, 2001.

Table 1. An overview of International Classification of Functioning, Disability and Health (ICF)

This framework starts with the concept of *health conditions*, which includes diseases, disorders, injuries and trauma. *Impairments* may occur to either body functions (e.g. reduce walking speed) or body structures (e.g. narrowing of a heart valve) (World Health Organization 2001). *Activity limitations* are difficulties an individual may have in executing activities relating to mobility, self care or domestic life (Jette AM and Keysor J 2003). *Participation restrictions* are problems an individual may experience. Disability and functioning are defined as umbrella terms (Marilyn J. Field and Alan M. Jette 2007). In the pictorial representation of the ICF (Figure 4), the terms disability and functioning do not exist. Disability and functioning are considered outcomes of interactions between health conditions and contextual factors.



Source: World Health Organization. International Classification of Functioning, Disability and Health. Geneva. WHO, 2001.

Fig. 4. The International Classification of Functioning, Disability and Health (ICF) 2001

The first element of the ICF, the Body Functions and Structures is similar to Nagi’s concept of pathology and impairment while the second component of the ICF, the Activities and Participation closely corresponds to Nagi’s concept of functional limitations and disability (Jette AM and Keysor J 2003)(as shown in Table 2). The greatest limitations of the ICF is the aggregation of “activities and participation” into one domain (Guralnik and Ferrucci 2009). Using the ICF, the concepts of activity limitation and participation restriction are difficult to separate, unlike Nagi’s concept of functional limitations and disability. The ICF currently does not offer crisp distinction between activity and participation, although there is an increasing movement towards defining “activities” and “participation”. The Institute of Medicine (IOM) discussed this concern in its report entitled Future of Disability in America (Marilyn J. Field and Alan M. Jette 2007). Some sections of the report cited verbatim are as shown below:

*“A first and well recognized aspect of the ICF that needs further development involves the interpretation and categorization of the concepts of activity and participation (page 42)”*



*“Several researchers have criticised the lack of clear operational differentiation between the concepts of activity and participation in the ICF as theoretically confusing and a step backward from earlier disability frameworks. Operational differentiation among concepts and the ability to measure each concept precisely and distinctly is important for clear communication, monitoring and research. (page 43)”*

*“Although this committee does not endorse any particular approach to resolving the problem, it believes that the lack of operational differentiation between the concepts of activity and participation is a significant deficit in the ICF. (page 44)”*

Since the ICF’s distinction between activity and participation is still in the developmental stage, many studies have used the Nagi Disablement Model as a conceptual framework in their research to understand the dynamic relationships among factors associated with physical function. Furthermore, the ICF is not inherently a dynamic model, similar to the ICD-10, the ICF is a classification system that offers standardized internationally accepted language. It is also worth noting that the Nagi Disablement Model has been successfully used as a theoretical pathway that was empirically tested in many datasets (Guralnik and Ferrucci 2009). For example, evidence demonstrates the predictive value of disease for impairment (arthritis causing reduced strength) (Guralnik and Luigi 2003), of impairment for functional limitations (reduced strength leading to reduced gait speed) (Guralnik and Ferrucci 2009) and of functional limitations for disability (lower extremity limitations leading to activity of daily living and mobility disability) (Penninx, et al. 2000).

	Anatomical body parts	Physiological functions of the body	Task performance	Involvement in life roles
Disablement Model	Pathology	Impairment	Functional Limitations	Disability
	Disease, injury, congenital condition	Dysfunctions and structural abnormalities in specific body systems	Restrictions in basic physical actions	The expression of a physical limitation in a social context
ICF	Body Functions and Structures Physiological functions of body systems and anatomical parts of body		Activities and Participation Activity : Execution of a tasks or action Participation: Involvement in a life situation	

Source: Jette AM, Keysor J. Disability Models: Implications for Arthritis Exercise and Physical Activity Interventions. Arthritis and Rheumatism (Arthritis Care and Research), 2003: 49; 114-120.

Table 2. The Disablement Model and the International Classification of Functioning, Disability and Health (ICF) frameworks.

5. Physical function measurement tools

Poor physical function can be assessed by using instruments based on self-report and by objective measurements or performance based tests. In the domain of physical and mobility

disability, self report and proxy report of difficulty or inability to perform ADLs and IADLs and mobility questionnaires have been the standard assessment tools (Guralnik and Luigi 2003; Kovar and Lawton 1994). There are more than 100 published basic ADL or IADL scales, with considerable variations in the number of questions, item content, and scoring method. Examples of some of the instruments used to measure disability include Katz ADL, The Barthel Index, Instrumental Activities of Daily Living Scale (IADL), and The Health Assessment Questionnaire (HAQ) Disability Scale. The comparison of the quality of the physical disability and mobility disability tools is as shown in Table 3. Objective measurements of disability are also available but are rarely used (Cress ME 1996; Kuriansky JB 1976). Recently, Cress *et al* have created the Continuous Scale-Physical Functional Performance (CS-PFP) test, a directly observed disability test battery done in a home and neighbourhood-like setting that includes items such as transferring clothes from a washer to a dryer, vacuuming, making a bed and loading and carrying groceries.

Similarly, functional limitation may be accessed through self-report, proxy report or through performance based tests. A large number of physical performance measures, either individual tests or batteries of tests, have been developed and many of them assess different aspects of functional limitation. Some examples of performance tests commonly used are the Tinetti Performance Oriented Mobility Assessment Tool, Walking Speed, Functional Independence Measure and Timed Up and Go (TUG) test. The comparison of the quality of the functional limitation tools is as shown in Table 4.

All in all, poor physical function has been assessed with a wide variety of instruments. There is no single best way to perform an assessment and there is no single instrument that is ideal. The lack of standardization that results from the use of multiple instruments makes it difficult to compare findings across studies (Jette 1994; Kovar and Lawton 1994; Wiener, et al. 1990).

## **6. Prevalence of poor physical function**

### **6.1 Prevalence of physical disability, mobility disability and functional limitation in developed countries**

Several studies in developed countries have sought to gauge the prevalence of physical disability, mobility disability and functional limitation among older people.

The basic set of either the six-item ADL or the five-item ADL has been found to be most useful for valid comparison across studies. Using the six-item ADL, the prevalence of disability from the National Long-Term Care Survey in the United States ranges from 12.4% to 13.2 % from 1982 to 2005 (Lafortune 2007). Disability surveys that capture five-item ADL show lower prevalence of disability:- 6% in Canada, 10% in France and 11% in Sweden (Lafortune 2007). Using the five-item ADL, significant variations in disability have been reported between populations in the United States, China and Singapore (Chen, et al. 1995; Ng, et al. 2006; Wiener, et al. 1990; Zhe, et al. 1999). In the United States, the prevalence of five-item ADL among older people aged 65 years and over was 8.1% in the 1987 National Medical Expenditure Survey, 5.8% in the 1984 Survey on Income and Program Participation and 5.0% in the Supplement on Ageing Survey. In Asia, the prevalence of five-item ADL among older people aged 65 years and over was: 8.3% among Shanghai Chinese in the 1987 Shanghai Survey of Alzheimer's Disease and Dementia, and 6.6% among Singaporeans in the 2003 National Mental Health Survey of the Elderly.

	Instrument tool	Purpose	Description	Studies Using Method	Reliability	Validity
1.	Barthel Index	The Barthel Index measures functional independence in personal care and mobility.	It takes two to five minutes to complete. Two main versions exist: the original ten-item version and an expanded 15-item version proposed by Granger, called the Modified Barthel Index. Each item is rated in terms of whether the patient can perform the task independently, with some assistance, or is dependent on help (McDowell 2006).	Many	Ten-item version Collin <i>et al</i> studied agreement among four ways of administering the scale: self report, assessment by health care based on clinical impression, assessment by a nurse and testing by a physiotherapist. Kendall's coefficient of concordance among the four rating methods was 0.93 (McDowell 2006).	Wade and Hewer reported correlations between 0.73 and 0.77 with an index of mobility ability for 976 patients. A factor analysis identified two factors which approximate the mobility and personal care groupings of the items (McDowell 2006). Evidence for a hierarchical structure in the scale in terms of the order of recovery functions was also provided(McDowell 2006). Predictive validity has also been assessed. In studies of stroke patients, the percentage of those who died within six months of admission fell significantly ( $p<0.001$ ) as Barthel scores at admission rose. Among survivors, admission scores also predicted the length of stay(McDowell 2006).
2.	Katz Index of ADL	The Index of ADL was developed to measure the physical functioning of elderly.	The Index of ADL assesses independence in six activities: bathing, dressing, using the toilet, transferring from bed to chair, continence and feeding. The six activities included in the index were found to	Many	Katz <i>et al</i> assessed inter-rater reliability and found differences between observers occurred once in 20 evaluations or less frequently(McDowell 2006). Guttman analyses on 100 patients in Sweden yielded coefficients of scalability ranging from 0.74 to 0.88, suggesting that the index forms a successful cumulative scale (McDowell 2006)	At a two year follow-up, Katz found that the Index of ADL predicted long term outcomes as well as or better than selected measures of physical or mental function(McDowell 2006). Brorsson and Asberg reported that 32 of 44 patients rated as independent at admission to hospital were living at home one year later whereas eight had died(McDowell 2006). By contrast 23 of 42 patients initially rated as dependent had died and only eight

	Instrument tool	Purpose	Description	Studies Using Method	Reliability	Validity
			lie in a hierarchical order of this type whereas other items (e.g. mobility, walking, stair climbing) did not fit the pattern and were excluded.			were living in their homes(McDowell 2006). Asberg also examined the ability of the scale to predict length of hospital stay, likelihood of discharge home and death (n=129). In predicting mortality, sensitivity was 73% and specificity was 80%; in predicting discharge, sensitivity was 90% and specificity, 63%(McDowell 2006).
3.	Physical Self-Maintenance Scale	The Physical Self Maintenance Scale is a measure of disability for elderly people living in the community or institution.	Brody and Lawton developed two scales: the six ADL items and an eight-item IADL scale. This scale can be administered separately or together. (Total no of items = 14).	Many	The six ADL items fell on a Guttman scale. The order of items was feeding (77% independent), toilet (66% independent), dressing (56%independent), and bathing (43% independent), grooming (42% independent) and ambulation (27% independent). A Guttman reproducibility coefficient of 0.96 was reported (n=265)(McDowell 2006).  The IADL items formed a Guttman scale for women but not men, owing to gender bias in the housekeeping, cooking, and laundry items; the reproducibility coefficient was 0.93(McDowell 2006). A Pearson correlation of 0.87 was obtained between pairs of nurses who rated 36 patients; the agreement between two research assistants who independently rated 14 patients was 0.91(McDowell 2006).	The PSMS correlated 0.62 with a physician's rating of functional health (n=130)(McDowell 2006). Roskwood <i>et al</i> found the PSMS ADL questions to be less responsive (standardized response mean 0.10) than the Barthel Index (SRM 1.13) in evaluating the impact of comprehensive geriatric intervention programs (McDowell 2006) The IADL questions were slightly better than the ADL but still not useful in detecting change.

	Instrument tool	Purpose	Description	Studies Using Method	Reliability	Validity
					Very high six-month test retest reliability has been reported: 0.94 for the ADL scale (item range, 0.84-0.96) and 0.88 for the IADL scale (item range 0.80 -0.99)(McDowell 2006).	
4.	Organization for Economic Cooperation and Development (OECD)Disability Questionnaire	The OECD questionnaire is a survey instrument that summarizes the impact of ill health on essential daily activities. It was intended to facilitate international comparisons of disability and, through repeated surveys, to monitor changes in disability over time.	Of the 16 questions, ten can be used as an abbreviated instrument and represent a core set of items for international comparisons.	Several	Wilson and McNeil used 11 of the 16 questions with slight modification in interviews that were repeated after a two-week delay (n=233)(McDowell 2006). The agreement between interviews was low, ranging from 30% to 70% for the 11 items. Considering the scale as a whole, less than two thirds of those who reported disabilities on either interview reported them on both(McDowell 2006).	Twelve of the OECD questions were included in a Switzerland survey for the elderly (aged 65 years and over) (n=1600). Sensitivity ranged from 61% to 85% for different medical conditions; highest for those with hearing, vision and speech problems. Specificity was 76%(McDowell 2006).
5.	Rapid Disability Rating Scale	The Rapid Disability Rating Scale was developed as a research tool for summarising the functional capacity and mental status of elderly. It may be used with hospitalised patients and with	This scale has 18 items, covering physical (communication, hearing, sight, diet, confined in bed, incontinence and medication),mental functioning (mental confusion, uncooperativeness, depression) and	Several	Inter-rater reliability of the 18 item version with two nurses independently rated 100 patients and items corrections ranged from 0.62 to 0.98; the three lowest correlations were for the mental status items. Test-retest reliability on 50 patients after an interval of three days produced correlations between 0.58 and 0.96(McDowell 2006).	Ratings of 845 men (mean age 68 years) were used to predict subsequent mortality using multiple regression and discriminant function analysis. Twenty percent of the variance in mortality was explained; the item correctly identified 72% of patients who died(McDowell 2006).

	Instrument tool	Purpose	Description	Studies Using Method	Reliability	Validity
		people living in the community.	independence in self-care (eating, walking, mobility, bathing, dressing, toileting, grooming and adaptive tasks)  This rating scale is administered by a nurse or a person familiar with the patient			
6.	Health Assessment Questionnaire (HAQ)	The Stanford Health Assessment Questionnaire measures difficulty in performing activities of daily living.	The full HAQ instrument covers five dimensions, but development work has concentrated on two most commonly used dimensions; the disability and discomfort dimensions. They are referred to as "Short or 2-page HAQ"  The disability dimension includes 20 items on daily functioning during the past week (dressing and	Many	The Spearman correlation for the disability index was 0.85, whereas correlations for individual sections ranged from 0.56 (IADL activities and hygiene) to 0.85 (eating). Two week test re-test reliability of the disability section was investigated with 37 patients with rheumatoid arthritis, showing no significance difference by t-test and a Spearman correlation of 0.87(McDowell 2006).  Fries <i>et al</i> administered the HAQ on successive occasions and obtained a test-retest correlation of 0.98 after 6 months(McDowell 2006).	Principle component analysis has broadly confirmed the dimensions originally postulated by Fries. The eight disability subscales are substantially correlated with each other; with a median correlation of 0.44 (McDowell 2006).  Fries compared self administered HAQ responses to performance made during house visit (n=25). The Spearman correlation for the overall score was 0.88, whereas correlations for component scores ranged from 0.47 (arising) to 0.88 (walking)(McDowell 2006).



	Instrument tool	Purpose	Description	Studies Using Method	Reliability	Validity
			grooming, arising, eating, walking, hygiene, reach, grip and outdoor activities)			
8.	Medical Outcomes Study Physical Functioning Measure	The Medical Outcome Study Physical Functioning Measure offers an extended ADL scale, suitable for use in health surveys and outcome assessment for outpatient care.	The Medical Outcome Study Physical Functioning Measure includes ten items on functioning, one on satisfaction with physical activity and three on mobility (Total no of items = 14).	Few	Eight of ten physical function items correlated 0.70 or greater with the overall physical scale score; the vigorous activity item correlated 0.62 and the bathing or dressing item showed a lower correlation of 0.48. Internal consistency for the functioning score was 0.92; and 0.71 for the mobility scale(McDowell 2006).	The physical functioning scale scores correlated 0.58 with the mobility scores and 0.63 with the satisfaction scores(McDowell 2006).

Table 3. Comparison of the physical disability and mobility disability assessment tools

	Instrument tool	Purpose	Description	Studies Using Method	Reliability	Validity
1.	Tinetti Performance Oriented Mobility Test	The Tinetti Test has been recommended and widely used in the elderly to assess mobility, balance and gait, as well as predicting falls.	The performance test of balance and gait during manoeuvres in normal daily activities. The Tinetti test takes about 10 minutes to administer.	Many	Berg <i>et al</i> found that the inter-rater reliability is 85% (Berg, et al. 1992).	With the Berg scale, $r = 0.91$ , with stride length, $r = 0.62$ to $0.68$ and with single leg stance, $r = 0.59$ to $0.64$ (Berg, et al. 1992).
2. 2.1	Walking Speed Tests 6 meter walking speed	Walking speed tests are the most frequently used objective physical performance test to evaluate functional limitations of the lower limbs.	The test performed over 2.44 meters, 4 meters and 6 meters at usual gait speed	Many	Test-retest reliability on 97 patients after one day (among hospital inpatient sample) and one week (among community dweller sample) produced inter class correlation (ICC) of 0.94 (Sherrington and Lord 2005) One study reported excellent inter-rater reliability (ICC 0.99) , $n=20$ (Rehm-Gelin, et al. 1997).	Predictive validity has been assessed. In studies of elderly, the $< 1m/s$ RR of mortality and hospitalization was 1.64 and 1.48 respectively during one year of follow up (Cesari, et al. 2005). Predictive validity has been assessed for risk of hip fracture where the RR for 1 SD decrease is 1.4 during a mean follow-up of 1.94 years (Dargent-Molina, et al. 2002).
2.2	2.44 meter walking speed				Test-retest reliability on 136 patients after an interval of three weeks produced inter class correlation of 0.72 (Osthega, et al. 2000). One study reported adequate inter-rater reliability (ICC 0.52) , $n=256$ (Osthega, et al. 2000)	Predictive validity assessed for mortality showed OR of 3.64 (Quartile 1: slowest), 2.57 (Quartile 2) and 2.16 (Quartile 3) compared to Quartile 4 (fastest) over a 2 year period(Markides, et al. 2001).
2.3	4 meter walking speed				Test-retest reliability after an interval of one week produced inter class correlation of 0.84 (Studenski, et al. 2003).	Predictive validity assessed for mortality showed HR 2.23, 95 % CI 1.44 – 3.64, within 5 years (Perera, et al. 2005).

3.	Functional Independence Measure	The Functional Independence Measure scale assesses physical and cognitive disability in terms of level of care required.	The Functional Independence Measure includes 18 items covering independence in self care, sphincter control, mobility, locomotion, communication and cognition. Items are scored on the level of assistance required for an individual to perform these activities. It takes half an hour to score the scale for each patient.	Many	Kappa coefficient of agreement for the 18 item is 0.54 (McDowell 2006).	Content validity was performed and factor analyses have identified three factors: handicap, disability and lower limb problems (McDowell 2006).
4.	Timed Up and Go Test	The purpose of Timed Up and Go Test is to assess basic mobility skills of elderly populations(McDowell 2006)	The Timed Up and Go test involves timing a person as they rise from a chair, walk three meters, turn and return to the chair. It takes approximately 2 minutes to complete.	Several	Three studies reported excellent inter-rater reliability (ICC 0.98 to 0.99)and excellent intra-rater reliability (ICC 0.97 to 0.99)(McDowell 2006).	Six studies reported fair to moderate correlations of the Timed Up and Go Test with Berg Balance Scale (r = 0.47), Tinetti Performance Oriented Mobility Assessment (r=0.55), Clinical Test of Sensory Interaction and Balance (r=0.44) and Multi-Directional Reach Test (r=0.26-0.42)(McDowell 2006).

Table 4. Comparison of the functional limitation assessment tools.

Mobility disability is very common among older people. Results from a United States National Prevalence Survey of Disability revealed that among older people aged 65 years and over, 30% had difficulty with mobility (Nordstrom, et al. 2007). In the United Kingdom, the Hertfordshire Cohort Study found that 32% of men and 46% of women aged 59 years and over reported that their health limited them in performing mobility activities (Syddall, et al. 2009). Data from the Netherlands National Health Survey showed that approximately 18% and 37% of older Dutch people aged 65 to 74 years and 75 years and over respectively reported mobility disability (Picavet and Hoeymans 2002).

Assessing functional limitation adds valuable information about the steps in the disability pathway. Gait speed, often termed walking speed has been regarded as the best single measure to evaluate functional limitation (Guralnik and Luigi 2003). It has also shown to be a strong and consistent predictor of adverse outcomes in older people. In a pooled analysis of individual data from nine major cohorts, gait speed has been shown to be a predictor of mortality in older people (Studenski, et al. 2011). In the same study, Studenski standardized the method to assess gait speed from different lengths (8 feet, 4 meters, or 6 meters) to a 4-meter-long track starting from a still, standing position. Using a recommended cut-off point of 0.8 meter/second as increased likelihood of poor health and function, the percentages of older people with poor mobility were : 44.2% in the Cardiovascular Health Study, 40.8% in the Established Populations for Epidemiologic Studies of the Elderly (EPESE), 84.1% in the Hispanic EPESE, 69.4% in the National Health and Nutrition Examination Survey III (NHANES III), 34.6% in the Predicting Early Performance Study and 21% in the InCHIANTI Study (Invecchiare in Chianti Study) (Studenski, et al. 2011).

## **6.2 Prevalence of physical disability, mobility disability and functional limitation in developing countries**

The burden of poor physical function has been studied extensively in developed countries but there is little data available for older people in developing countries. Comparison of physical disability, mobility disability and functional limitation distribution between countries is difficult due to methodological differences in definition and measurements used. Surveys from around the world used different approaches in measuring disability. Different instruments within the same country often report different rates. Across countries the variation is even more cumbersome. Nevertheless, the studies discussed below used comparable methods to a certain extent.

Prevalence studies on the five-item ADL disability among older people had been carried out in several low income developing countries. The Cambodian study in 2004 showed a prevalence of 23.7% among older people aged 60 years and over (Zimmer 2008); the 1998 Housing and Population Census of the Ethiopian Government reported a prevalence of 28.6% among Ethiopians adults aged 55 years and above (Teferra 2005). In addition, two studies were conducted in Nepal among older people aged 60 years and above with prevalence of 8.8% in Kathmandu city, 2005 and a much higher prevalence of 55.8% in rural Chitwan Valley, 1998 (Shrestha 2004).

Studies on the five-item ADL disability among older people in lower middle income developing countries reported varied prevalence: 10% and 9% among older people aged 65 years and over in Sri Lanka (Nugegoda and Balasuriya 1995) and urban Chinese in Shanghai

(Chen, et al. 1995) respectively. Whereas, among older people aged 60 years and over, the prevalence were: 12% in Indians (Shantibala, et al. 2007), 10.9% and 14.7% in Filipinos in the years 1996 and 2001 respectively (Ofstedal et al), 6.5% in Beijing Chinese (Zhe, et al. 1999), 18.7% in Indonesian men and 12.1% in Indonesian women (Evi Nurvidya Arifin 2009).

Several studies in lower middle income countries have used six-item ADL scales. In the WHO Collaborative Study on Social and Health Aspects of Aging in 1990, the prevalence of six item ADL disability among older people age 60 and over was: 22.4% in Egyptian men, 28.5% in Egyptian women, 32.0% in Tunisian men and 46.8% in Tunisian women (Yount and Agree 2005). The Ibadan Study of Aging in Nigeria in 2004 reported the prevalence of six-item ADL disability at only 3% among Nigerians aged 65 years and over (Oye Gureje, et al. 2006). The prevalence of disability among Nigerians is low because of the difference in criterion definition used. In the Ibadan Study of Aging, disability is based on difficulty experience with four levels of responses. This resulted in a more restrictive definition of disability, as compared to studies that defined disability based on any level of difficulty.

Many studies on the prevalence of physical disability were conducted in upper middle income countries. From the Survey on Health and Well-Being of Elders. Palloni *et al* reported that the prevalence of six-item ADL disability among older people were: 19% in Argentina, 14% in Barbados, 24% in Brazil, 26% in Chile, 21% in Cuba, 19% in Mexico and 17% in Uruguay (Palloni and McEniry 2007). The prevalence of six-item ADL disability among older people aged 60 years and over in Puerto Rico in a 2003 study was 20% (Palloni, et al. 2005).

The epidemiology of poor physical function among older people in developing countries is incompletely understood with many unanswered questions.

## 7. Risk factors for poor physical function

Several factors have been identified as risk factors for disability and functional limitation. These include non-modifiable risk factors (e.g. gender, ethnicity and genetics) and modifiable risk factors, which include both individual factors (such as sedentary lifestyle, unhealthy behaviours) as well as characteristics of the environment (e.g. household hazards, disadvantaged neighbourhood conditions, common forms of transportation).

### 7.1 Gender, ethnic group, socioeconomic and health-related factors

Poor physical function had been reported to be associated with increasing age (Tas, et al. 2007a), being female (Tas, et al. 2007a), lower socioeconomic status (Tas, et al. 2007a), chronic diseases (Tas, et al. 2007a), depression (Tas, et al. 2007a), visual impairment (Ng, et al. 2006), cognitive impairment (Ng, et al. 2006), poor self rated health (Ng, et al. 2006), fewer social support (Tas, et al. 2007b), living alone (Ng, et al. 2006) and lack of exercise (Wu, et al. 1999).

The association between female gender and poor physical function is consistently reported in many studies. Some studies have shown that the higher prevalence of poor physical function in female is unexplainable by known differences in sociodemographic and health related factors (Auxiliadora Graciani, et al. 2004; Dunlop, et al. 1997).

There are few reports of ethnic differences in frequency of poor physical function. How differences in sociodemographic and health-related factors explain the ethnic differences in poor physical function is still unclear. Older black and Hispanic Americans have a higher prevalence of poor physical function than their white counterparts (Kelly-Moore and Ferraro 2004). Other studies from the United States have found that African-American have higher disability rates compared to the Whites even after adjustment for education (Liao, et al. 1999) and chronic disease (Kingston and Smith 1997), although one study reported that social and health factors explained these differences (Kelly-Moore and Ferraro 2004). Ng *et al* showed that Indians and Malays in Singapore have higher risk of disability than Singaporean Chinese (Ng, et al. 2006).

Older people in less advantaged socioeconomic positions report more physical disability, mobility disability and functional limitation. Lower level of education tends to be associated with a higher prevalence of poor physical function at all ages (Lafortune 2007). A lower level of education is often associated with lower income, lower standards of living, higher risk of work-related injuries, and adoption of less healthy behaviours. The “education” effect has been shown to be a proxy for broader “socioeconomic status”.

Changes in the prevalence of chronic diseases play a dominant role in explaining the prevalence of poor physical function among older people. However, not all diseases are associated with poor physical function and some are more strongly associated than others. Diseases with large effects on poor physical function include stroke and other neurological diseases, diabetes, heart diseases, depression, arthritis and other musculoskeletal diseases (Avlund 2004). It has also been reported that the presence of more than one chronic disease in an individual, often called co-morbidity is associated with poor physical function (Guralnik, et al. 1993; Schmitz, et al. 2007). Guralnik *et al* showed that the presence of a single chronic disease is a significant predictor of poor physical function, with the risk increasing incrementally up to the presence of four or more chronic diseases (Guralnik, et al. 1993).

There is also some evidence of association between smoking, heavy alcohol consumption and lack of physical activity with poor physical function (Tas, et al. 2007b).

The majority of studies on risk factors for poor physical function have focused on chronic diseases and lifestyle behaviours. There are a number of health-related factors that have rarely been investigated. These include the co-existence of depression and visual impairment; chronic pain; and the role of muscle strength, muscle mass (sarcopenia) and muscle quality.

## **7.2 Co-existing depressive symptoms and visual impairment as risk factors of poor physical function**

The accumulation of deficits across more than one health domain, including physiological, sensory, cognitive and psychological domain, is likely to explain the development of poor physical function better than decline in just one single health domain. Whitson *et al* showed that individuals with co-existing visual impairment and cognitive impairment are at high risk of disability (Whitson, et al. 2007). Lin *et al* showed that the burden of having both vision and hearing impairment is greater than the sum of each single impairment (Lin, et al. 2004). Rantanen *et al* reported that the odds of severe mobility disability were ten times



greater among those who had both strength and balance impairments compared to those with just one or other impairment (Taina Rantanen, et al. 2001). Thus, it appears that certain pairs of co-existing conditions have a strong effect on physical function risk.

Depression and visual impairment are common conditions among older people and are also modifiable to a certain degree; depression can be treated and visual impairment can be corrected. However, it is unclear whether there is a synergistic effect of depressive symptoms (psychological health domain) and visual impairment (sensory domain) on the risk of poor physical function among older people.

### 7.3 Chronic pain and poor physical function

There are gender-based differences in mortality and morbidity; with men experiencing higher mortality rates and women generally having higher levels of morbidity (Steven M Albert and Vicki A Freedman 2010). In the pain literature, a robust and common finding is that women reported more pain, have lower pain thresholds and tolerance, and show different attitudes in coping with pain as compared to men (Roger, et al. 2009; Unruh 1996). Longitudinal and cross sectional population based studies have shown that the impact of pain goes beyond physical distress (Keogh, et al. 2006). The presence of pain is also associated with poor physical function (Duong, et al. 2005).

In contrast to gender differences in pain, the evidence about gender differences in pain outcomes, such as poor physical function, remains inconclusive. Cunningham *et al* found no difference in musculoskeletal pain related restriction in daily activities between genders (Cunningham and Kelsey 1984). The Health, Aging and Body Composition (ABC) Study also found no gender differences in the relationship between low back pain and physical function (Weiner, et al. 2003). However, studies that used pain-related disabilities items as an outcome found there were gender differences in reporting pain-related disabilities (Keefe, et al. 2000; Réthelyi, et al. 2001; Stubbs, et al. 2010).

### 7.4 Sarcopenia as risk factors for poor physical function

It is well established that the aging process in humans is associated with loss of muscle mass and strength (Doherty 2003; Y Rolland 2008). Age-related decline in muscle mass has been documented by lean body mass measurements with dual X-ray absorptiometry (DXA) and muscle cross sectional areas quantified by imaging methods such as X-ray computed tomography (CT) and magnetic resonance imaging (MRI). The age-related loss of muscle mass results from loss of both slow and fast motor units, with an accelerated loss of fast motor units. These changes in muscle morphology results in sharp age-related changes in muscle strength and muscle function (Lang, et al. 2010). Muscle quality is an indicator of muscle function, quantified by strength per unit muscle mass. Another morphological aspect of aging skeletal muscle is the infiltration of muscle tissue components by lipids. The aging process is thought to result in increased frequency of fat cells within muscle tissue (Anne B. Newman, et al. 2003).

Age-related loss of muscle mass, strength and quality is called “sarcopenia”. Recent longitudinal studies have demonstrated that age-related loss of muscle strength increases the risk of poor physical function among older people (Giampaoli, et al. 1999; Taina

Rantanen, et al. 2001). Perhaps because of the various operational definitions used, the relationship between age-related muscle mass (sarcopenia) and poor physical function has not been consistent (I Janssen 2006; MJ. Delmonico, et al. 2007).

## 8. Conclusion

In summary, poor physical function – physical disability, mobility disability and functional limitation is developing as the population ages. Poor physical functions are complex processes with multiple risk factors at work (Steven M Albert and Vicki A Freedman 2010). As such, multifactor interventions are needed to improve and maximize older people's physical functions. Identifying the appropriate target population and window of time for targeting an intervention is critical to its success. Furthermore, the issue of sustainability and adherence to these interventions are also important for long term success (Steven M Albert and Vicki A Freedman 2010). Research up to date is still incomplete in guiding public health practitioners and clinicians as to which interventions will improve and maximize older people's physical function in the long run.

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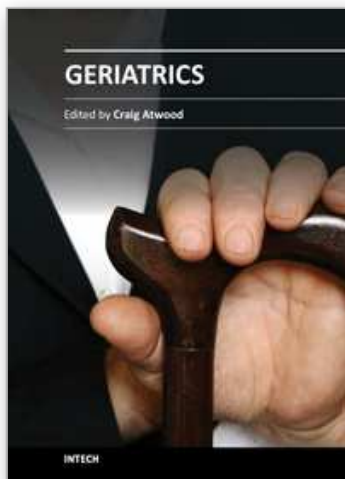
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## **Geriatrics**

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With the baby boomer generation reaching 65 years of age, attention in the medical field is turning to how best to meet the needs of this rapidly approaching, large population of geriatric individuals. Geriatric healthcare by nature is multi-dimensional, involving medical, educational, social, cultural, religious and economic factors. The chapters in this book illustrate the complex interplay of these factors in the development, management and treatment of geriatric patients, and begin by examining sarcopenia, cognitive decline and dysphagia as important factors involved in frailty syndrome. This is followed by strategies to increase healthspan and lifespan, such as exercise, nutrition and immunization, as well as how physical, psychological and socio-cultural changes impact learning in the elderly. The final chapters of the book examine end of life issues for geriatric patients, including effective advocacy by patients and families for responsive care, attitudes toward autonomy and legal instruments, and the cost effectiveness of new health care technologies and services.

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