THE IMPACT OF ASSISTIVE TECHNOLOGY DEVICE USE ON THE SOCIAL PARTICIPATION LEVELS OF OLDER ADULTS

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ABSTRACT

Background: Although particularly important to aging adults, societal participation and civic engagement in the form of volunteering, religious participation, membership in social organizations, and even visiting with friends and family is often not possible because of debilitating physical conditions. Options that focus on reducing task demand to reduce disability and improve the independence of older Americans may improve social participation. Assistive Technology Devices (ATDs) are tools that help people with physical limitations perform activities they might otherwise be unable to perform, but the link between ATD use and social participation among older adults has received little attention in the academic literature.

Data and Methods: Data from two waves of the National Health and Aging Trends Study (NHATS) are used to examine the use of assistive devices by those with mobility or sensory impairments or those who need help in performing critical daily activities. We consider the ties between device use and the individual's participation in five separate types of social activities, including visiting with family and friends, participating in

religious services, joining clubs and attending meetings, going out for enjoyment and performing volunteer work. We apply two different analytical approaches; first a logistic regression model obtains marginal effects to show how the probability of participation is expected to change as each key independent variable changes, and then a first difference model is used to difference away any possible unobserved individual-specific time-invariant factors.

Results: The use of hearing aids emerges as the most dominant device in explaining how likely older adults are to participate, particularly in religious services, joining clubs and volunteering. Contrary to intuition, however, we find that the use of walkers among those with mobility needs is negatively associated with participation in these same activities. For almost all social participation categories, those who presented with issues performing activities of daily living benefit from the use of bathing devices.

Conclusions: Paying for the health and long-term care needs of older Americans is a key issue facing U.S. policymakers today. This work shows that certain assistive technology devices, particularly hearing aids, can contribute to an increase in many forms of community participation that should aid in the addition of Social Capital among older adults.

INTRODUCTION AND SIGNIFICANCE

Although particularly important to aging adults, societal participation and civic engagement in the form of volunteering, religious participation, membership in social organizations, and even visiting with friends and family is often not possible because of debilitating physical or mental conditions. Yet, civic engagement and community participation as well as the resulting social capital, are vital for a society to be safe, healthy, happy and prosperous. Most studies of social capital have focused on social capital as the independent variable influencing different outcomes (Coleman, 1993; Coleman and Iso Ahola, 1993; Hull, 1990; Parker, 1996).

Given the importance of social capital gained through civic engagement, Kreuter and Lezin (2002) suggest it is time we examine the extent to which specific mechanisms promote, enhance or create social capital and social engagement. Without some assistance in the form of personal care or assistive technologies, many seniors may be less able to engage in social activities and reap the benefits provided by social capital which may be linked to both improved health and reduced medical care spending. However, little work has been done on the relationship between assistance in the form of assistive technology devices (ATDs) and societal participation.

Using two waves of a large nationally representative sample of older adults, this work considers the impact of a variety of assistive technology devices on five types of social participation: visiting with family and friends, participating in religious services, joining clubs and attending meetings, going out for enjoyment and performing volunteer work. The analyses are conducted for three different samples: older adults with mobility

limitations, older adults with sensory (e.g. hearing or vision) limitations, and older adults who need help with activities of daily living (ADLs).

To our knowledge, this is the first study to consider a range of different types of social participation by individuals with specific limitations and to examine the impact of a wide range of assistive devices on social participation, controlling for important confounding factors. The results from this work allow for a deeper understanding of the relationship between ATDs and social participation and may inform public policies around payment for such devices for older adults.

The increased independence gained through the use of ATDs could reduce the demands of disability care on both families and public programs for older adults with disabilities (Spillman, 2005). On the other hand, lack of individual financial resources to purchase these aids represents an environmental barrier that could result in social disparity. With limited government resources, it becomes important to distinctly evaluate particular devices, since some will have larger impacts than others.

LITERATURE

Two streams of literature are particularly relevant for this work: literature on social capital and literature on assistive technology devices and their use.

SOCIAL CAPITAL AND FUNCTIONAL LIMITATIONS

In *Democracy in America* Alexis de Tocqueville (2003) recognized an equality among the American people that led to a "society of one single mass" within which there existed no true aristocracy, but rather a blending of social ranks. Lacking a powerful ruling class, Americans had to band together in associations directed harmoniously and methodically toward reaching a common goal. These frequent interactions between

members of society create an inherent norm of generalized reciprocity with an expectation that folks will reward good deeds done to them by doing good deeds of their own. A society characterized by this concept of reciprocity runs more efficiently than a distrustful one since there is a mutual benefit for all parties leading to socially desirable outcomes (Putnam, 2000). This connection among individuals, through norms of reciprocity and trust was first coined as "social capital" in the early twentieth century by a West Virginia educator named L.J. Hanifan and has since been formerly theorized and applied within many disciplines including political science, sociology and economics. Joseph Coleman, a prominent American sociologist, popularized the concept of social capital in the 1980s and 1990s as a bridge between social context theory and the economic theory of independent rational choice (Coleman, 1988). Harvard Public Policy professor Robert Putnam has built on the early work of Coleman, and has brought the notion of social capital and the importance of civic engagement to the forefront, in scholarly journals and to mainstream audiences through his best-selling book *Bowling alone: The collapse and revival of American community* (Putnam, 2000).

Social capital has been described as the norms, networks and mutual trust of civil society that facilitates cooperative action among citizens and institutions (Perkins & Long, 2002) and is gained through changes in relations among people or organizations that affect behavior (Coleman, 1988). There are individual, organizational and community benefits put forth by the social capital theory. The trust inherent in social interaction allows for smooth conduct of business and social transactions (Putnam, 2000). Although not referring to social capital directly by name, Elinor Ostrom's work (2008) suggests a similar theory of collective action for dealing with the problems of common

pool resources whereby individuals organize themselves voluntarily to retain the residuals of their own efforts. Frequent interaction with others also broadens our experiences making us more empathetic towards and tolerant of other races, religions and cultures. Individually we benefit from contacts made and the increased flow of information and advice available when we join a social group, visit with friends and family, or mingle after a church service. This could lead in turn to further civic activity as we try to use this new information to organize others toward the public good. Social capital therefore represents resources for our success in the form of emotional, practical and economic support that we may not have as individuals.

One of the greatest positive impacts of this social integration has been its apparent association with individual health status (Berchet & Jusot, N.d.; Scheffler et al., 2010). At the community level, health and wellbeing can be improved through the diffusion of health information, the introduction of healthy behavioral norms, promotion of access to local services and healthy psychological and emotional support from peers. Visiting with loved ones provides opportunities for informal, spontaneous assistance which is so much a part of everyday life that its contribution to improved health is often not recognized (Israel, 1985). Religious attendance has also been shown to have a strong impact on improving poor health behaviors, as well as sustaining good mental health and emotional well-being through increased social relationships (Strawbridge et al., 2001). There have been many published studies and meta-analyses that show evidence that individuals who are socially disconnected are more likely to die earlier (House, Landis, & Umberson, 1988; Holt-Lunstad, Smith & Bradley, 2010), self-report poorer health (Kawachi et al, 1999), and even commit suicide (Emile Durkheim, 1966). In their review for the World

Health Organization, Marmot and his colleagues write that "the most effective actions to achieve greater health equity at a societal level are actions that create or reassert societal cohesion and mutual responsibility." (2012, page 1012).

While there is much literature on factors that improve the functional capabilities of older adults, little work has been done on the impact of changes in functional capabilities on the social activities of older adults. The WHO's 2001 International Classification of Functioning, Disability and Health (ICF) emphasizes the importance of what people actually do, as opposed to what they are capable of doing. Following the ICF, recent literature has called for research that measures the impact on outcomes beyond the mere enhancement of functional capabilities (Scherer and Glueckauf, 2005). One measure considered the most meaningful outcome in the rehabilitation literature is the impact on one's daily activities and participation in community life (Cooper et al., 2011). By improving one's capacity to perform and facilitating independence, assistive technology offers the person with limited functionality the potential to acquire a sense of autonomy and meaningful connection to the community (Scherer et al., 2005).

ASSISTIVE TECHNOLOGY DEVICES AND THEIR USE

Typical strategies to cope with functional limitations include the use of personal assistance, assistive devices or a combination of the two. The use of both formal and informal care giving assistance has been researched extensively and includes a number of studies to determine the impact of assistive technology when used along with personal care (Agree et al., 2005; Taylor & Hoenig, 2004). These show that the use of assistive technology has become relatively more prevalent in attempts to meet the needs of this country's older population (Cornman, Freedman and Agree, 2005). In fact, Verbrugge

and Sevak (2002) found evidence that people with moderate to severe disability were more likely than those with mild disability to use assistive equipment without personal care. They theorize that persons with disability often strive for autonomy in their situation and using assistive devices entails more control than personal assistance.

As used in the following essay, assistive technology devices (ATDs) are tools that help an older person with limitations to perform physical activities that might otherwise be difficult or impossible for them. They include low- to high-tech solutions ranging from walkers to motorized scooters, and items such as magnifying glasses and sound amplification devices. They also include modifications to the home that can be as simple as grab bars in the bathroom or more sophisticated modifications such as stair lifts and elevators. This research will focus on ATDs in three distinct categories: mobility devices, sensory devices and devices that aid with the performance of ADLs.

Mobility Assistive Equipment are a commonly used type of ATD to facilitate transfers, walking and wheeled mobility, and the performance of mobility-related ADLs. Examples of these devices include canes (the most basic unit), walkers (pick-up, wheeled and seated varieties), self-propelled wheelchairs (used by those unable to ambulate a reasonable distance) and power mobility devices such as motorized wheelchairs and scooters. It is rare that a single private or public insurer will pay 100% of the cost of these mobility devices although in the U.S., Medicare Part B may cover up to 80% of the cost if a) the healthcare practitioner provides a written prescription and b) the purchase meets a 9-point, function-based Clinical Criteria for Mobility Assistive Equipment coverage (CMS, 2009). In addition to mobility limitations, this criteria also considers other conditions such as the existence of cognitive or sensory impairments, availability of

caregivers and one's physical environment. Although Medicaid has the distinction of being the largest overall payor of long term care, funding for all types of ATDs through 1915(c) HCBS waivers are unevenly distributed across states. While there has been a rise in the number of Medicaid participants receiving ATD, this growth has not kept pace with the growth of Medicaid waiver programs overall (Kitchener et al., 2008).

Although mobility devices are generally accepted as improving balance control and are thought to have a direct physical and psychological effect on the health of the user, some evidence indicates a high prevalence of difficulty with use, discomfort, pain and even injury due to disrupting balance control by diverting other attentional mechanisms such as vision (Bateni and Maki, 2005).

Sensory Device use is also quite prevalent among those over age 65. Vision and hearing limitations not only make communication difficult, but they also impede mobility and restrict one's ability to perform ADLs and instrumental activities of daily living (IADLs). Despite their importance, correctional lenses and routine eye exams are not covered by Medicare (or for that matter by many Medicare Advantage and private insurance plans), unless it is for one pair of conventional eyeglasses or contact lenses furnished subsequent to cataract surgery with insertion of intraocular lenses. Hearing aids and examinations for hearing aids are likewise not covered by Medicare (CMS, 2013). "Dual eligibles," those enrolled in both Medicaid and Medicare may be entitled to payment for eyeglasses and hearing aids; but, again, this is subject to individual states' program eligibility and payment limits.

Devices that Assist with ADLs include feeding devices, dressing aids, and bathing and toileting assists.

- *Feeding* - Besides providing adequate nutritional intake, eating is also the most social of all ADLs. It is estimated that 24% of those aged 85 and older cannot feed themselves independently (Brummel-Smith and Dangiolo, 2009). Devices in this category include lightweight utensils with large handles, cutlery with plastic hand straps, rubberized placemats, and cups with anti-splash lids or dual handles.
- *Dressing* - Our choice of clothing contributes to our self-identity and being unable to dress (remaining in nightclothes and slippers, for example) may lead to isolation for those who are unable to perform this activity. There may be several reasons for this problem including pain, decreased range of motion and inability to make decisions about what to wear. Dressing aids include buttonhooks, zippers with grab loops, Velcro fasteners, etc. Although they are usually inexpensive, without advice, some people may not realize they are available or how to obtain and use them.
- *Bathing* - Difficulty with bathing is associated with a high incidence of falls and increased odds of hospitalization and admission to skilled nursing facilities. If individuals adapt by not bathing, it also has repercussions for one's social engagement and participation. Modifications to the bath may include grab bars, bath benches, rubber mats, or a walk-in or wheelchair accessible shower.
- *Toileting* - Devices include raised toilet seats and grab bars. Problems with toileting are similar to those for bathing.

METHODOLOGY

HYPOTHESES

The following hypotheses regarding the relationship between social participation and ATD use are considered:

H1: The use of mobility devices (in particular canes, walkers, wheelchairs and scooters) among older adults with mobility impairments will have a positive impact on their likelihood of participation in the forms of visiting friends and family, attending religious services, being involved in club activities, going out for enjoyment and volunteering.

H2: The use of sensory devices (namely, hearing and vision aids) among older adults with sensory impairments will have a positive impact on their likelihood of participation in the forms of visiting friends and family, attending religious services, being involved in club activities, going out for enjoyment and volunteering.

H3: The use of devices to aid with activities of daily living (such as eating, bathing, toileting and dressing devices) among older adults with ADL difficulties will have a positive impact on their likelihood of participation in the forms of visiting friends and family, attending religious services, being involved in club activities, going out for enjoyment and volunteering

DATA

As previously noted, the WHO's 2001 International Classification of Functioning, Disability and Health shifted the focus of rehabilitative care from medical cause to impact (Bachmann et al, 2010). In line with this new disability measurement protocol, a new database from the National Health and Aging Trends Study (NHATS) includes items that not only support the scope of traditional measures of functioning, but expand on it by including items to measure participation (through assistive devices), as well as restrictions in valued activities (Freedman et al., 2011). The main distinction in the data is among persons living in residential care settings that are nursing homes, residential care settings other than nursing homes, and all other community settings. Since data pertinent to our study are not available on nursing home residents, they are excluded.

The NHATS is a nationally representative sample of individuals aged 65 and older, drawn from the Medicare enrollment file and oversamples persons at older ages and Black individuals. It consists of two waves with study participants first interviewed in 2011 and then again in 2012. Our model considers those in the original interview who also appeared in the second year for a total of approximately 12,100 total observations in the full sample. In testing the three hypotheses, we consider the effect of the use of assistive devices on one's participation in various social activities, allowing for a number of confounding items. The hypotheses are premised on need and the use of any assistive device by one who has no potential for benefit would be irrelevant. Therefore, we limit our subsamples to three groups of older adults (those 65+) each corresponding to a separate hypothesis: a) those having actual or perceived problems with mobility, b) those with sensory problems and c) those experiencing problems performing ADLs. Cornman,

Freedman and Agree (2005) find that differing definitions of functioning used in disability studies may distort the interpretations of the effect of device use on functionality. We therefore take care to include a potentially sizeable group that the authors describe as a pre-clinical disability category, which includes those who may use a device as a prophylactic measure (e.g. to prevent a fall). To derive an indicator of need, we cross-tabulate variables that measure one's level of difficulty performing a task by themselves with an indicator for whether they used a device to perform a specific task, excluding only those who did not use a device and indicated they had no difficulty performing related tasks alone.

EMPIRICAL APPROACH

Descriptive Statistics

First, the analysis provides descriptive statistics, by wave, for the full sample of respondents and tests to measure significant changes between the waves.

Multivariate Analysis

Two different analytic approaches are used to examine the relationship between device use and whether or not the observed individual participates in a certain type of social activity, controlling for a number of covariates. As noted above, five different individual social activities are considered, where each activity is modeled separately using a binary indicator for participation. In addition, the analyses are also done on three different subsets of the data, where each subset relates to one of the three categories of physical limitations: mobility limitations, sensory limitations, and problems with performance of ADLs.

Logistic Regression with Random Effects Models

The first set of analyses compares the probability of participation in an activity for those who currently use ATDs and those who do not use them, controlling for a variety of confounders. A logistic regression model with random effects is used to obtain average marginal effects, intended to show how the probability of participation is expected to change as each key independent variable changes from 0 to 1, holding all other variables constant (Williams, 2012). Random effects are used when the unobserved, unit-specific effect is assumed to be uncorrelated with the explanatory variables.[1]

The logistic regression with random effects analyses use the following model:

$$\Pr(Part_{it} = 1|x_{it}) = \Phi\,(\beta_1 ATD_{it} + \beta_2 Barrier_{it} + \beta_3 Interest_{it} + \beta_4 Environ_{it} + \beta_5 SocSup_{it} + \beta_6 ADL_{it})$$

where Φ represents the cumulative logistic distribution function. $Part_{it}$ is a dichotomous variable that represents participation (by individual i in period t) in one of the five chosen social activities in the past month (visiting family or friends, attending religious services, participating in club meetings, going out for enjoyment, or doing volunteer work).

The main explanatory variables of interest are included in the vector ATD_{it} that indicates the existence of assistive technology device use, as operationalized by a

[1] We also considered conditional logistic regression analyses, which are analogous to an analysis similar to a fixed effects logistic regression model to look at the effect of ATD use on the probability of participation in an activity. Fixed effects models are useful if you suspect that you have unobserved, individual-specific, time-invariant characteristics which affect the dependent variable and are correlated with one or more explanatory variables. If ignored, the coefficients on the explanatory variables that are correlated with the unit-specific effect may be biased. Fixed effects models work by holding constant the average effects of each individual and as such rely on within-group variation to identify the coefficients. Conditional logistic analysis differs from ordinary logistic regression in that the data are grouped at the individual level and the likelihood of the outcome is calculated relative to each person. In attempting to execute the conditional logistic model, we discovered that it dropped many observations because there were no changes in the dependent variable, leaving us with an inadequate sample size. Therefore, results from the conditional logistic regression models are not reported.

dichotomous indicator for the use of each type of device: cane, walker, wheelchair, scooter, or a device to facilitate with hearing, vision, eating, bathing, toileting or dressing. Each model includes only the ATDs pertinent to the individual's functional limitation. For example, in testing H1 using a sample of individuals with mobility limitations, *ATD* includes only those variables indicating the use of a cane, walker, wheelchair or scooter. For those with functional limitations, ATDs have been shown to be effective in improving the individual's functioning by reducing task demand (Verbrugge and Sevak, 2002), improving one's capacity to perform and offering the person with limited functionality the potential to acquire a sense of autonomy and meaningful connection to the community (Scherer et al., 2005).

Those sampled were asked directly if they had used a mobility device with the question "In the last month have you used a cane, walker, wheelchair or scooter, yes or no?" They were further queried to see which particular mobility device was used, providing dichotomous variables for the use of each device. Similar questions were also asked of hearing aid or hearing device use and glasses, contacts or other vision devices for distance or close-up vision. Finally they were asked questions on device use for self-care activities, such as "In the last month did you ever use adaptive utensils to help you eat or cut your food?" and comparable questions regarding toileting, dressing and bathing.

$Barrier_{it}$ contains items that represent potential barriers to participation such as health and transportation problems within the last month pertaining directly to the measured activity, and $Interest_{it}$ indicates whether the person finds each social activity important.

Environ$_{it}$ refers to a large vector of personal environment factors such as one's age, gender, race/ethnicity, level of education, residential status, and household income. Given that physical and cognitive health are necessary to be able to participate in social activiites, self-reported measures of current health and an indicator of whether the individual has been diagnosed with dementia are also included.

SocSup$_{it}$ measures the availability of social support for the individual, as well as his perception of his social environment, and includes items for family status, level of personal care, and perceptions of community. Gottlieb (1983) defines social support as "…verbal and non-verbal information or advice, tangible aid or action that is proffered by social intimates or inferred by their presence and has beneficial or behavioral effects on the recipients." *SocSup* includes a number of variables that are in concert with these themes and tend to encourage or discourage participation among older people. They include marital status, number of children, and average hours of caregiving received. Social support literature also reveals that persons who maintain contact with at least one confidant report better mood, greater life satisfaction, and better health than those without such a strong tie (Gottlieb, 1985). Therefore, we have included a variable derived in the NHATS data that indicates whether or not the person "has no one to talk to." In addition, the survey ascertains the respondents' perceptions of their community by asking whether the respondent agrees with the following three statements: that people in their community know each other well, that they are willing to help each other, and that they can be trusted.

ADL$_{it}$ is also a vector whose items measure whether or not the individual has a problem performing an activity of daily life without relying on either human assistance or

device use. One is considered to have mobility problems if they had problems with either getting out of bed or a chair, going outside, or moving around the house. Problems with hearing and vision are measured separately, as are problems with eating, bathing, toileting and dressing. Because the variable is used as a screening variable to develop subsamples, only problems with activities outside of those aided by the ATD of interest are included as controls. For example when measuring the effect of sensory devices for those who need them, only problems with mobility and with the four ADLs are used in the model.

First Difference Models

We also estimate all models using the first difference estimator, which differences away any unobserved individual-specific, time-invariant factors. Liker et al. (1985) suggest it as a useful tool under a number of circumstances that are relevant to our analysis, namely where unmeasured and time-invariant explanatory variables may be correlated with the observed variables and secondly when the measures of a change in the variables from the first to second period may be a more reliable measure than the measure of the variable in only one time period. Since this regression's assumptions of a normal distribution for the dependent variable and homogeneous error variance are violated when applied to a binary dependent variable, we estimate this model simply to check for differences between this approach and the random effects logistic regression results.

RESULTS

DESCRIPTIVE STATISTICS

Table 1 shows the percentage of all those observed in both waves one and two, who participated in each activity.

The highest participation levels are shown for those visiting with family and friends, at over 86% for both waves. Over three-quarters of the people in the study enjoyed things such as going out for dinner or to a movie or play, although this is largely correlated with marital status and age. Only 69% of those who were unmarried went out for enjoyment, compared to over 81% of married people, and by age the percentage varies from 83.7% of those age 65-69 to 60.3% of those over 90. Religious involvement is down slightly in the second wave, but the change is not statistically significant. Though averaging around 58 - 60% for all age groups in the two waves, it peaks for those between 74 and 79, who report 64.2% participation. It also varies by ethnicity with a larger portion of Black, non-Hispanics in the 65-69 age range (72.5%) indicating they attend religious services. The table also tells us that for those individuals who remain in the study there is little statistical difference from the first wave to the second in participation levels other than in doing volunteer work, which also decreases significantly among older members of the population, from a high of 29.4% of the 65-69 population to only 12.4% among the oldest in the sample.

Table 2 gives descriptive statistics of ATD use (the main explanatory variables) and indicates that there are some significant changes in the device use of individual respondents from one wave to the next, the most prominent being increases in the use of walkers, wheelchairs, and bathing and toileting devices.

Mobility devices are used by 29% of the sample population in the first wave, but device use increases significantly to over 32% in wave two. The majority use canes and walkers, with less frequent use of wheelchairs and scooters, although the percentage of the sample using wheelchairs did increase by 1.1%. Walker use as a percentage of the population is up a very significant 2.4%.

The use of eyeglasses or contacts is very common among those sampled, at over 93% in both waves. This is consistent with other national samples that indicate that as people get older, their use of visual aids grows rapidly (CDC, 2011). Although loss of hearing is also very prevalent among older adults, hearing device use is rarer in the sample, with only a slight and non-significant increase in wave two. Device use for assistance with daily activities varies greatly. Less than 1% claim they are using eating devices and approximately 3.5% use devices to help with dressing but a much larger percentage use grab bars and other bathroom accessories to help with toileting and bathing. This use also increases significantly in wave two.

Table 3 provides descriptive statistics for the remainder of the variables. As you can see, many more people in both waves of the sample named their health (10 - 15%), rather than transportation (1 - 5%) as a barrier to participating in all types of activity. While this number increases slightly in wave 2, the changes are not statistically significant. All but approximately 12% feel that visiting family and friends is at least somewhat important, fewer attached importance to attending religious services (≈ 75%) and going out for enjoyment (≈ 77%), and 46.6% of wave one respondents and 48% of wave two respondents feel that participating in clubs is not important at all. There is but one significant difference in these opinions between the two waves.

A majority (58%) of the respondents are female and the sample is evenly distributed by age, other than there being fewer people in the 85-89 and over 90 age groups. Far more people are living in the community (94.8%) than in residential care and this percentage changes little in wave two. Approximately 27% of those surveyed report poor/fair health in both waves, but the incidence of being diagnosed with dementia increases dramatically in wave two (2.3% increase, $p < .001$). The percentage working for pay decreases from 15.1% to 13.3% and this is also significant ($p < .01$). The percentage of respondents still driving is quite high in both waves, although it decreases from 70.6% to 67.1% in wave two ($p < .001$).

NHATS derives a particularly pertinent measure of Social Support that indicates whether the sample person "has no one to talk to" and the data show that 6.5% fall into this category in the first wave. By the second wave, this number drops to 4.7% ($p < .001$). Also along the lines of Social Support, a majority agree to some extent with all three positive statements about their community and the only one that shows significant change is a wave-to-wave decline in those who agree that members of their community knew each other well.

A large percentage of those surveyed, had problems with vision (over 95%) in both waves. For those needing help with ADLs, toileting, bathing and dressing show significant increases in the second wave. Most of the confounding items that show significant changes from the first to the second waves represent progressions related to aging and include those diagnosed with dementia (increases by 2.3%, $p < .001$), those working for pay (decreases by 1.8%, $p < .01$), those still driving (down 3.5%, $p < .001$) and a slightly significant decrease in those who were married.

LOGISTIC REGRESSION WITH RANDOM EFFECTS RESULTS

Results of the first set of logistic regression analyses, which consider the association of existing ATD use and current participation levels, are shown in Tables 4 through 6. With some notable exceptions, the effect of assistive technology device use on participation levels among older persons does not appear to be overwhelming. For example, there is little evidence that whether or not an individual uses any assistive device explains why he socializes with family and friends or goes to the movies or to dinner. As shown in Table 4, relating to the first hypothesis, when mobility devices have a significant impact it is generally negative, even when controlling for a number of other factors. Most prominently, the use of walkers is shown to detract from the likelihood that an individual participates in many social activities. Using a walker decreases the probability of attending religious services by over 5 percentage points ($p < .001$), of joining a club by 4.4 percentage points ($p < .01$) and of volunteering by 2 percentage points ($p < .05$). Wheelchair utilization is also negatively associated with the probability of attending religious services ($p < .05$). The use of a motorized scooter did increase the probability that an individual would join a club or participate in club meetings ($p < .05$), but has no significant impact on one's participation in any of the other listed activities. Remembering that our subsample includes only those who had a physical need for such devices, these results run quite contrary to the first hypothesis, which presumed a positive impact of mobility device use on participation among older adults.

In Table 5 vision devices, though commonly used, are shown only to have significant positive impact on the probability of going out for enjoyment. The table shows that using vision aids increases the probability of going out for enjoyment by 5.1

percentage points when compared to those not using these vision aids ($p < .05$). Conversely, the use of hearing aids among those with sensory impairments shows consistently positive and quite significant results in three cases. The table illustrates that those who currently use a hearing aid have a significantly higher probability of attending religious services (3 percentage points greater, $p < .01$), joining clubs and attending meetings (3.1 percentage points greater, $p < .01$) and volunteering (5.6 percentage points greater, $p < .001$) than those not using a hearing device. The high significance associated with hearing aid use makes it possible to at least partially accept the second hypothesis that the use of sensory devices has a positive impact on many types of participation among older adults.

Of all devices used by those with ADL limitations, Table 6 shows that current use of bathing devices has significant and positive effects on the greatest number of activities ($p < .05$) Bathing device use is positively associated with a greater probability of visiting family and friends (by 1.7 percentage points), attending religious services (by 2.8 percentage points), joining clubs (by 2.1 percentage points) and participating in volunteer activities (by 2.3 percentage points). Those who use toileting devices are also 3.6 percentage points more likely to be volunteering ($p<.05$) than those who had toileting problems but did not use an assistive device. Those who used eating devices, however are less likely to volunteer than those who do not use them. These instances of a greater probability of participation among those using devices lend some limited support to uphold our third hypothesis.

Tables 4 through 6 show that other variables other than ATD use are shown to have far stronger and more significant effects on participation levels. Health and

transportation issues are likely to have significant negative impacts on one's propensity to participate in all activities, while finding the activity important has a very positive one ($p < .001$ among all sampled groups, for all activities). Other environmental factors such as continuing to drive are positively associated with greater likelihood of participation in all activities ($p < .001$) and living in residential care is strongly associated ($p < .001$) with attending religious services and joining clubs. Increasingly higher academic achievement is consistently associated with higher rates of participation, most significantly in activities besides visiting family and friends. Being male is generally shown to reflect decreased participation with varying degrees of significance, but particularly for those who have sensory difficulties. Also, having an ethnicity other than White is generally associated with lower probability of participation, with the exception of attending religious services where Blacks and Hispanics report higher attendance than Whites. Blacks in particular are significantly less likely than Whites to participate in visiting family and friends, joining clubs and going out for enjoyment in all of the subsamples. Other non-White, non-Hispanics (which include Asians, Pacific Islanders, Native Hawaiians and American Indians) are far less probable to volunteer than Whites. Having good health is shown to be a clear indicator of increased participation for all activities except for visiting family and friends, while being diagnosed with dementia interferes only with volunteering ($p < .01$).

The effect of social support on activity participation is inconsistent. Family status (particularly having two or more children) is positively significant only to one's inclination to visit family or go out for enjoyment. Having no one to talk to is significantly and negatively associated with visiting family and friends ($p < .005$ for all

subsamples), attending religious services ($p < .05$) and going out for enjoyment. In general, one's perceptions of community are most often a positive influence on his or her probability of participation, though not always significantly so.

FIRST DIFFERENCE MODEL RESULTS

The results from the first difference models are shown in Table 7 (those with mobility problems), Table 8 (those with sensory problems) and Table 9 (those needing help with ADLs). Note that in these tables, a small number of variables (gender, education, children and race) are omitted since there is no within-group variance in the variable between waves.

Table 7 shows that, similar to the previous analysis, the use of some mobility devices decreases the probability that the individual will choose to participate in a number of activities. For example, when a person went from not using a walker to using one, the probability of visiting with friends and family, going out for enjoyment and volunteering does not change, but the probability that he will attend religious services decreases by over five percentage points ($p < .05$) and the probability that he will join a club decreases by 4.7 percentage points ($p < .05$). Likewise the use of a cane leads to a decrease in volunteering (3.2 percentage points, $p < .05$) On the other hand, a positive change in scooter use is positively associated with an increase in joining clubs and volunteering ($p < .05$).

We see from Table 8, that the impact of changes in sensory device use on changes in participation is minimal. The only significant p-values concern a positive association between new vision aid use and an increased likelihood of going out for enjoyment ($p < .05$).

Finally in Table 9, considering those who require assistance to perform ADLs, we note only one effect of a change in the use of devices to help with eating, bathing, toileting or toileting on any type of participation, and that is a negative effect of an increase in the use of a dressing device on religious service attendance.

Looking beyond the key variables of interest, Tables 7, 8 and 9 show that changes in other factors contribute to one's propensity to participate. Moving into residential care indicates a very positive impact on joining clubs and attending religious gatherings for individuals with mobility and sensory problems as well as for those with ADL limitations. Interestingly, neither a change in the diagnosis of dementia nor a change in reported health status has any apparent impact on a change in participation level. Working for pay continues to be positively associated with going out for enjoyment among those with mobility problems ($p < .05$), but not for those with sensory problems or who need help with ADLs. Among all subsample groups, continuing to drive has a positive and somewhat significant influence on all activities, with the exception of visiting family and friends.

Health barriers remain a significant problem for participation for all groups, particularly when it comes to visiting with family, attending religious services and going out for enjoyment, while transportation barriers have a significant and negative impact on religious activity ($p < .01$) and on joining clubs only for those with sensory problems ($p < .01$). Finding the activity important remains the most significant indicator for the likelihood of all types of participation with very highly significant results for all groups (most $p < .001$). In this analysis, changes in most social support variables have only minor impact on the probability of participation. A positive change in the feeling that one

has nobody to talk to has a significant and negative effect on the probability of visiting family and friends ($p < .001$), but a positive effect on the probability of volunteering ($p < .05$), at least for those with mobility issues. The effect of a change in the average amount of monthly caregiving on visiting family and friends is the most significant of the variables in the social support category. An increase of 10 hours of care per month, for example, would increase the probability of visiting with others by 7 percentage points for those who need help with mobility ($p < .01$) and sensory problems ($p < .001$), as well as for those who have difficulty performing activities of daily living ($p < .01$). The perception that one's community is willing to help are associated with a greater likelihood of volunteering among those with mobility problems ($p < .005$) and of attending club meetings for those needing help with ADLs ($p < .005$).

DISCUSSION AND POLICY IMPLICATIONS

Of the five social participation activities considered, this study reveals the highest participation rates for older adults occur for visiting with family and friends, which is to be expected as social support literature has shown for years that people will first go to natural helpers such as family and friends for advice, emotional and informational support and help with daily tasks (Cohen, 2004; Gottlieb, 1983). Still, most people want to do things for themselves, and how they choose to do so depends on the extent of their limitations, their personal preferences and goals, their social environment, and whether they feel that device use supports or undermines their sense of personal identity (Gitlin, Luborsky and Schemm, 1998). ATDs can facilitate independence and improve self-esteem for individuals with physical, sensory or mobility problems by enabling them to get around on their own, care for themselves and interact with others. Presumably this

independence would also allow them to engage in situations of daily life, such as visiting family and going out for enjoyment, attending religious services, joining clubs of interest and volunteering to help others.

Our study however shows a dichotomy in its two biggest revelations. On the one hand, it indicates that some devices such as hearing aids are influential in encouraging participation in many activities, but that mobility devices in particular are sometimes associated with less social activity. For example, results show an apparent negative impact of wheelchairs and walkers on attending religious services, joining clubs and volunteering. Although ATDs are designed to improve the health and psychosocial functioning of those who use them, sometimes their use may seem unsuitable for the individual and could, in itself, represent a barrier to participation. Haggblom-Kronlöf and Sonn's qualitative study of older adults (2007) describes a "contradiction" in the range of responses towards the social aspects of assistive device use. They found acceptance, but also uncertainty, embarrassment and vulnerability among the users of assistive devices outside the home in a social context.

Public, social and personal consequences of device use, such as lowered prestige, stigma and being viewed as a dependent person, may make someone think twice about using mobility devices in particular. Wheeled mobility devices, such as wheelchairs, for example, are highly visible signs of disability (in fact, the literal international symbol for handicap) and while their use may enable an individual to leave home, at the same time, it may be a reminder of diminished ability and make the individual self-conscious about participating in social activity. Despite more accessible buildings, housing, and recreational facilities as mandated by the Americans with Disabilities Act (ADA),

participation in society is still challenging for people who use mobility devices, and users of these devices make fewer trips outside the home and engage in fewer activities than people without disabilities (Harris, 2007).

Hearing devices are a different matter and are by far the most significant positive ATD predictor of participation in our study, as users are more likely than non-users to attend religious services, join clubs, and volunteer. Hearing serves a number of important functions. It enables spoken communication, provides an alarm for potentially injurious events, allows one to orient oneself, and serves an aesthetic function as in the appreciation of music or the voices of loved ones (Tesch-Römer, 1997). Presbycusis, or hearing loss which occurs mostly in older age, may therefore have a profound impact on the person's social, functional, and psychological wellbeing. Power and Hyde (2002) describe how people who are hard-of-hearing often report feeling lonely or isolated when they are unable to communicate with others, and this feeling of isolation may be subconsciously reinforced by friends, family, or care-givers in response to the increased effort required to communicate. Although results of empirical studies concerning a correlation between presbycusis and social integration are equivocal (Tesch-Römer, 1997), a study of nursing home residents by Resnick, Fries and Verbrugge (1997) associates more severe hearing impairment with low social engagement.

There is no cure for age-related hearing loss and many older people just accept hearing impairment as part of the aging process. However, hearing aids can improve hearing function in most cases. It has been estimated that only one in five older people with hearing problems seek assistance due to negative attitudes about hearing impairment and hearing aids, lack of knowledge of the options to treat hearing impairment, and

problems accessing audiological services (Howarth and Shone, 2006). Much of this access problem is likely financial. Although Medicare Part B will cover a diagnostic hearing or balance exam if a doctor orders it, Medicare will not cover routine hearing exams, hearing aids, or exams for fitting hearing aids (Centers for Medicare & Medicaid Services). Only thirty-two of the fifty U.S. states provide Medicaid benefits for hearing aids, generally covered more frequently for children than for adults, and often after a large co-pay (The Henry J. Kaiser Family Foundation, 2010). Since the data used in this study do not include the state in which the sample person lives, we cannot determine the extent of the individual's Medicaid coverage, nor can we assess the availability of devices, or trained personnel to assist with them.

Also, Demers et al. (2008) tell us that the likelihood for changes in life circumstances, abrupt or subtle, encourage taking a longitudinal approach to studying ATD use and its outcomes. Two waves of data, one year apart, are really insufficient to ascertain what the true longer-term effects of using assistive devices may have on participation. For example a change in use may have been precipitated by a recent event, such as a fall, a stroke or the start of physical therapy that might, in itself, have had a profound effect on one's ability and inclination to participate. Also, for many devices there is a "learning curve" during which an individual may opt not to participate in activities. We look forward to future waves of NHATS data which will allow future researchers to follow the trajectories of both device use and participation. Finally, while this study indicates that good hearing and communication abilities are important in allowing for increased participation, it does not go further in gauging the social capital gained, or measuring changes in health or medical care costs.

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TABLES

TABLE 1: Descriptive statistics for Social Participation Measures

	Wave 1		Wave 2			
	%	n	%	n	Diff.	Signif
Visits Family & Friends	86.3	6,051	87.3	6,049	1.0	
Attends Religious Services	59.8	6,053	58.2	6,046	(1.6)	
Join Clubs/Attend Meetings	36.8	6,052	36.9	6,046	0.1	
Goes Out for Enjoyment	75.0	6,051	75.3	6,052	0.3	
Does Volunteer Work	24.6	6,052	23.0	6,050	(1.6)	*

Notes: Data Source: National Health & Aging Trends Study, Waves 1 & 2, 2011-2012
full sample of individuals in wave 1, remaining in wave 2
* p < .05, ** p < .01, *** p < .001

TABLE 2: Descriptive statistics for Assistive Technology Device Use

	Wave 1		Wave 2			
	%	n	%	n	Diff.	Signif
Any Mobility Device	29.0	6,052	32.3	6,055	3.3	***
Cane	20.5	6,055	21.0	6,054	0.5	
Walker	14.0	6,055	16.4	6,055	2.4	***
Wheelchair	7.0	6,055	8.1	6,055	1.1	*
Scooter	2.5	6,055	2.5	6,055	0.0	
Any Hearing Device	13.7	6,037	14.6	6,036	0.9	
Any Vision Device	94.1	6,014	93.4	5,994	(0.7)	
Any Eating Device	0.8	6,052	0.8	6,042	0.0	
Any Bathing Device	39.3	6,038	42.3	6,038	7.0	**
Any Toileting Device	42.9	6,040	46.4	6,036	3.5	***
Any Dressing Device	3.4	6,052	3.6	6,050	0.2	

Notes: Data Source: National Health & Aging Trends Study, Waves 1 & 2, 2011-2012
full sample of individuals in wave 1, remaining in wave 2
* p < .05, ** p < .01, *** p < .001

TABLE 3: Descriptive statistics for control variables

	Wave 1		Wave 2			
	% or Mean	n	% or Mean	n	Diff.	Signif
Barriers to Participation (*Barrier*)						
Health Prevents (%)						
Visiting Family & Friends	9.6	6,049	10.0	6,048	0.4	
Attending Religious Services	14.6	6,051	15.1	6,043	0.5	
Participating in Clubs & Meetings	10.9	6,051	11.1	6,044	0.2	
Going Out for Enjoyment	10.6	6,048	11.3	6,047	0.7	
Doing Volunteer Work	11.1	6,052	11.4	6,048	0.3	
Transportation Prevents (%)						
Visiting Family & Friends	4.0	6,054	4.6	6,055	0.6	
Attending Religious Services	4.1	6,054	4.6	6,055	0.5	
Participating in Clubs & Meetings	3.3	6,054	3.5	6,054	0.2	
Going Out for Enjoyment	3.5	6,054	3.9	6,053	0.4	
Mean Number Other Limits	1.3	6,049	1.3	6,045	0.0	
Finds Activity Important (%) *(Interest)*						
Visiting Family & Friends						
Not Important	12.8	6,040	12.1	6,033	(0.7)	
Somewhat Important	25.9		26.5		0.6	
Very Important	61.3		61.4		0.1	
Attending Religious Services						
Not Important	24.8	6,043	25.3	6,026	0.5	
Somewhat Important	17.6		17.7		0.1	
Very Important	57.6		57.0		(0.6)	
Participating in Clubs						
Not Important	46.6	6,048	48.0	6,028	1.4	
Somewhat Important	23.8		23.6		(0.2)	
Very Important	29.6		28.4		(1.2)	
Going Out for Enjoyment						
Not Important	22.0	6,048	23.7	6,040	1.7	*
Somewhat Important	34.4		34.1		(0.3)	
Very Important	43.6		42.2		(1.4)	

Notes: Data Source: National Health & Aging Trends Study, Waves 1 & 2, 2011-2012
full sample of individuals in wave 1, remaining in wave 2
* p < .05, ** p < .01, *** p < .001

TABLE 3: Descriptive statistics for control variables (continued)

		Wave 1		Wave 2			
		% or Mean	n	% or Mean	n	Diff.	Signif
Environmental Factors (*Environ*)							
Gender (%)	Male	41.6	6,055	41.6	6,055	0.0	
	Female	58.4		58.4		0.0	
Age (%)	65-69	19.0	6,055	15.1	6,055	(3.9)	
	70-74	21.0		20.7		(0.3)	
	75-79	20.2		20.6		0.4	
	80-84	19.8		20.0		0.2	
	85-89	12.1		14.1		2.0	
	90+	7.9		9.5		1.6	
Race/Ethnicity (%)							
	White, non-hispanic	69.6	6,002	69.6	6,002	0.0	
	Black, non-hispanic	21.9		21.9		0.0	
	Other, non-hispanic	2.7		2.7		0.0	
	Hispanic	5.8		5.8		0.0	
Living Arrangement (%)							
	Residential Care	5.2	6,055	5.9	5,991	0.7	
	Community	94.8		94.1		(0.1)	
Diagnosed with Dementia (%)		5.0	6,051	7.3	6,051	2.3	***
Self-reported Current Health (%)							
	Poor/Fair	26.7	6,052	27.1	6,049	0.4	
	Good	32.4		33.1		0.7	
	Very Good/Excellent	40.9		39.8		(1.1)	
Highest Education (%)							
	Less than H.S. Diploma	26.2	6,000	26.2	6,000	0.0	
	High School Diploma	27.1		27.1		0.0	
	Some College	24.2		24.2		0.0	
	Bachelor's Degree	12		12		0.0	
	Advanced Degree	10.5		10.5		0.0	
Works for Pay (%)		15.1	6,053	13.3	6,051	(1.8)	**
Mean Family Income		49,608	6,055	n/a			
Still Drives (%)		70.6	6,055	67.1	6,054	(3.5)	***

Notes: Data Source: National Health & Aging Trends Study, Waves 1 & 2, 2011-2012
full sample of individuals in wave 1, remaining in wave 2

* p < .05, ** p < .01, *** p < .001

TABLE 4: Logistic regression with random effects:
Average marginal effects of device use and other factors on the probability of participation for those with mobility problems ^

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Uses Assistive Device *(ATD)*					
Cane	-0.002	0.020	0.010	-0.017	-0.014
Walker	0.002	-0.055 ***	-0.044 **	-0.001	-0.020 *
Wheelchair	-0.007	-0.044 *	-0.022	-0.035	-0.023
Scooter	-0.029	0.037	0.050 *	0.025	0.030
Barrier Prevents Participation *(Barrier)*					
Health Prevents	-0.076 ***	-0.113 ***	-0.025	-0.166 ***	-0.016
Transport. Prevents	-0.022	-0.108 ***	-0.064 **	-0.041	n/a
Finds Activity Important *(Interest)*					
Somewhat Import.	0.245 ***	0.374 ***	0.291 ***	0.393 ***	n/a
Very Import.	0.330 ***	0.804 ***	0.695 ***	0.517 ***	n/a
Social Support Factors *(SocSup)*					
Married	-0.003	0.010	-0.014	0.022	-0.009
Children 1	-0.015	-0.005	-0.018	0.041	-0.013
2-4	0.030	0.008	-0.005	0.059 **	-0.013
5+	0.048 *	0.021	-0.005	0.061 *	-0.007
Has noone to talk to	-0.120 ***	-0.073 *	-0.027	-0.074 *	0.007
Community:					
Knows each other well					
Agree a Little	0.014	0.005	0.037 *	-0.017	0.007
Agree a Lot	-0.005	-0.017	0.029	-0.063 **	0.020
Helps each other					
Agree a Little	0.012	0.028	0.025	0.051	0.041 ***
Agree a Lot	0.008	0.040	0.017	0.072 **	0.025 *
Can be trusted					
Agree a Little	0.031	0.003	0.014	-0.020	0.027 *
Agree a Lot	0.052 **	0.007	0.010	0.033	0.012
Avg. hours care/mo.	0.000	0.000	0.000	0.000	0.000 *
# Observations	4,535	4,536	4,542	4,540	4,546

^ Mobility includes getting out of bed or chair, going outside or moving around house.

* p < .05, ** p < .01, *** p < .001

n/a indicates question not asked of this activity

TABLE 4: Logistic regression with random effects (continued):
Average marginal effects of device use and other factors on the probability of participation for those with mobility problems ^

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Problem performing without help ++ *(ADL)*					
Vision	0.013	0.046	0.001	0.033	-0.003
Hearing	-0.021	-0.005	0.020	-0.004	0.025 **
Eating	-0.023	0.014	-0.006	-0.023	-0.002
Bathing	0.013	0.170	-0.019 *	0.003	-0.036 ***
Toileting	0.012	-0.004	0.017	0.001	0.020 *
Dressing	-0.007	0.033 *	-0.026 *	-0.026	-0.018 *
Environmental Factors *(Environ)*					
Living in Resid. Car	0.005	0.132 ***	0.099 ***	-0.047 *	0.022
Male	-0.022	-0.036	-0.029 *	-0.036 *	-0.018
Age 70-74	-0.037	0.033	-0.005	0.004	-0.012
75-79	-0.026	0.044	-0.006	-0.022	0.003
80-84	-0.032	0.050	0.027	0.010	-0.004
85-89	-0.024	0.039	0.041	-0.001	-0.023
90+	-0.042	0.020	0.026	-0.016	-0.023
Race/Ethnicity (White, non-Hispanic ref.)					
Black, non-Hisp.	-0.031 *	0.046 *	-0.012	-0.061 **	0.001
Other, non-Hisp.	-0.058	0.067	0.064	-0.001	-0.044 ***
Hispanic	-0.057 *	0.052	-0.041	-0.088 **	-0.032 **
Diag. with Dementia	0.038 *	-0.026	0.039	0.020	-0.047 **
Self-reported Current Health (poor ref.)					
Good	0.002	0.048 **	0.035 **	0.035 *	0.026 ***
V. Good/Excellent	-0.006	0.042 *	0.032 *	0.024	0.042 ***
Highest Education					
H.S. Diploma	0.053 ***	0.078 ***	0.027	0.026	0.017 *
Some College	0.038 *	0.061 **	0.067 ***	0.078 ***	0.025 **
Bachelor's Degree	0.030	0.104 ***	0.095 ***	0.071 **	0.065 **
Advanced Degree	0.049	0.108 ***	0.137 ***	0.054	0.155 ***
Works for Pay	0.049 *	0.113 ***	0.063 **	0.083 **	0.041 **
Still Drives	0.052 ***	0.088 ***	0.065 ***	0.097 ***	0.063 ***
# Observations	4,535	4,536	4,542	4,540	4,546

^ Mobility includes getting out of bed or chair, going outside or moving around house.

++ help entails human assistance or device use.

* p < .05, ** p < .01, *** p < .001

TABLE 5: Logistic regression with random effects:
Average marginal effects of device use and other factors on the probability of participation for those with sensory problems ^

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Uses Assistive Device *(ATD)*					
Any Vision Device	0.004	0.019	-0.013	0.051 *	0.020
Any Hearing Device	0.014	0.030 **	0.031 **	0.021	0.056 ***
Barrier Prevents Participation *(Barrier)*					
Health Prevents	-0.048 ***	-0.084 ***	-0.041 **	-0.121 ***	-0.051 **
Transport. Prevents	-0.011	-0.085 ***	-0.085 ***	-0.032 *	n/a
Finds Activity Important *(Interest)*					
Somewhat Import.	0.199 ***	0.483 ***	0.384 ***	0.355 ***	n/a
Very Import.	0.256 ***	0.900 ***	0.819 ***	0.451 ***	n/a
Social Support Factors *(SocSup)*					
Married	0.003	0.019 *	-0.001	0.019 *	-0.017
Children 1	0.009	-0.002	0.003	0.035 *	-0.016
2-4	0.032 **	0.014	0.016	0.039 **	-0.006
5+	0.035 **	0.015	0.015	0.039 **	-0.003
Has noone to talk to	-0.061 ***	-0.032 *	-0.023	-0.057 ***	-0.013
Community:					
Knows each other well					
Agree a Little	0.010	0.003	0.026 *	-0.008	0.023
Agree a Lot	0.008	0.002	0.015	-0.030 **	0.048 **
Helps each other					
Agree a Little	0.014	0.028 *	-0.006	0.024	0.035
Agree a Lot	0.015	0.035 *	-0.006	0.039 *	0.040 *
Can be trusted					
Agree a Little	0.014	0.004	0.020	-0.017	0.030
Agree a Lot	0.020 *	-0.001	0.020	0.013	0.014
Avg. hours care/mo.	0.000	0.000 *	0.000 *	0.000	0.000 **
# Observations	10,549	10,549	10,556	10,556	10,562

* p < .05, ** p < .01, *** p < .001
n/a indicates question not asked of this activity

TABLE 5: Logistic regression with random effects (continued):
Average marginal effects of device use and other factors on the probability of participation for those with sensory problems ^

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Problem performing without help [++] *(ADL)*					
Mobility [^]	-0.019 **	-0.017	-0.012	-0.007	-0.053 ***
Eating	-0.014	-0.004	-0.005	-0.015	0.032
Bathing	0.005	-0.023 *	-0.026 *	-0.006	-0.075 ***
Toileting	0.003	-0.002	0.014	0.005	0.019
Dressing	-0.001	0.014	-0.024 *	-0.017	-0.058 ***
Environmental Factors *(Environ)*					
Living in Resid. Car	0.017	0.083 ***	0.080 ***	-0.035 *	0.056 *
Male	-0.022 ***	-0.039 ***	-0.024 **	-0.017	-0.047 ***
Age 70-74	-0.019 *	0.010	0.003	-0.017	-0.003
75-79	-0.026 **	0.026 *	0.002	-0.036 **	0.037
80-84	-0.037 ***	0.025 *	0.020	-0.019	-0.018
85-89	-0.032 **	0.013	0.040 *	-0.032 *	-0.039 *
90+	-0.051 ***	-0.006	0.020	-0.046 **	-0.053 *
Race/Ethnicity (White, non-Hispanic ref.)					
Black, non-Hisp.	-0.024 **	0.030 **	-0.040 ***	-0.055 ***	-0.007
Other, non-Hisp.	-0.037 *	0.030	-0.009	-0.041	-0.096 ***
Hispanic	-0.032 *	0.040 *	-0.042 *	-0.057 **	-0.087 ***
Diag. with Dementia	0.024 *	-0.014	0.046 *	0.015	-0.091 *
Self-reported Current Health (poor ref.)					
Good	0.039	0.031 **	0.014	0.030 **	0.054 ***
V. Good/Excellent	0.012	0.037 ***	0.031 **	0.040 ***	0.087 ***
Highest Education					
H.S. Diploma	0.020 **	0.055 ***	0.048 ***	0.033 **	0.038 ***
Some College	0.018 *	0.056 ***	0.089 ***	0.057 ***	0.088 ***
Bachelor's Degree	0.026 *	0.091 ***	0.112 ***	0.059 ***	0.076 ***
Advanced Degree	0.031 **	0.094 ***	0.157 ***	0.079 ***	0.271 ***
Works for Pay	0.001	0.016	0.035 **	0.024 *	0.042 **
Still Drives	0.035 ***	0.068 ***	0.057 ***	0.063 ***	0.144 ***
# Observations	10,549	10,549	10,556	10,556	10,562

[^] Mobility includes getting out of bed or chair, going outside or moving around house.

[++] help entails human assistance or device use.

* p < .05, ** p < .01, *** p < .001

TABLE 6: Logistic regression with random effects:
Average marginal effects of device use and other factors on the probability of participation for those with ADL problems

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Use Assistive Device *(ATD)*					
Any Eating Device	-0.033	0.020	0.007	-0.060	-0.138 *
Any Bathing Device	0.017 *	0.028 *	0.021 *	0.012	0.023 *
Any Toileting Device	0.019	-0.027	0.016	0.004	0.036 *
Any Dressing Device	0.028	-0.013	-0.030	0.010	-0.021
Barrier Prevents Participation *(Barrier)*					
Health Prevents	-0.068 ***	-0.105 ***	-0.043 **	-0.153 ***	-0.062 ***
Transport. Prevents	-0.014	-0.093 ***	-0.089 ***	-0.048 *	n/a
Finds Activity Important *(Interest)*					
Somewhat Import.	0.191 ***	0.428 ***	0.347 ***	0.353 ***	n/a
Very Import.	0.263 ***	0.850 ***	0.770 ***	0.467 ***	n/a
Social Support Factors *(SocSup)*					
Married	-0.008	-0.001	0.005	0.013	-0.016
Children 1	0.003	0.018	0.003	0.043	-0.032
2-4	0.033 *	0.014	-0.002	0.047 *	-0.004
5+	0.040 **	0.029	-0.001	0.052 *	-0.008
Has noone to talk to	-0.080 ***	-0.037	7.000	-0.059 *	-0.013
Community:					
Knows each other well					
Agree a Little	0.012	0.002	0.026	-0.012	0.005
Agree a Lot	0.006	-0.005	0.021	-0.049 **	0.036 *
Helps each other					
Agree a Little	0.005	0.032	0.010	0.045 *	0.042 *
Agree a Lot	0.002	0.057 *	0.009	0.062 **	0.039
Can be trusted					
Agree a Little	0.040 *	-0.003	0.014	-0.013	0.031
Agree a Lot	0.047 **	-0.018	0.005	0.022	0.018
Avg. hours care/mo.	0.000	0.000	0.000	0.000	-0.001 *
# Observations	5,740	5,745	5,745	5,748	5,753

* $p < .05$, ** $p < .01$, *** $p < .001$
n/a indicates question not asked of this activity

TABLE 6: Logistic regression with random effects (continued):
Average marginal effects of device use and other factors on the probability of participation for those with ADL problems

		Participation Activity				
		Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Problem performing without help [++] *(ADL)*						
Mobility [^]		-0.027 *	-0.028 *	-0.035 **	-0.025	-0.053 ***
Vision		-0.007	0.037	0.003	0.030	-0.010
Hearing		-0.022 *	0.002	0.008	-0.010	0.048 ***
Environmental Factors *(Environ)*						
Living in Resid. Care		0.002	0.087 ***	0.079 ***	-0.050 *	0.037
Male		-0.022 *	-0.021	-0.027 *	-0.019	-0.017
Age	70-74	-0.014	0.011	-0.008	-0.017	-0.004
	75-79	-0.033 *	0.021	-0.002	-0.031	0.002
	80-84	-0.034 *	0.004	0.013	-0.015	-0.029
	85-89	-0.023	-0.001	0.028	-0.023	-0.042
	90+	-0.046 *	-0.028	0.009	-0.036	-0.059 *
Race/Ethnicity (White, Non-Hispanic ref.)						
Black, non-Hisp.		-0.030 **	0.038 **	-0.033 *	-0.073 ***	0.000
Other, non-Hisp.		-0.072 *	-0.001	-0.007	-0.003	-0.103 ***
Hispanic		-0.054 *	0.024	-0.044	-0.074 **	-0.050 *
Diag. with Dementia		0.034 *	-0.021	0.046 *	0.010	-0.104 **
Self-reported Current Health (poor ref.)						
Good		0.006	0.043 **	0.030 *	0.045 ***	0.065 ***
V. Good/Excellent		-0.002	0.047 **	0.039 **	0.044 **	0.080 ***
Highest Education						
H.S. Diploma		0.031 **	0.066 ***	0.043 **	0.025	0.053 ***
Some College		0.014	0.058 ***	0.080 ***	0.061 ***	0.081 ***
Bachelor's Degree		0.025	0.108 ***	0.112 ***	0.086 ***	0.128 ***
Advanced Degree		0.024	0.100 ***	0.120 ***	0.051 *	0.192 ***
Works for Pay		0.024	0.016	0.043 *	0.050 *	0.047 **
Still Drives		0.050 ***	0.077 ***	0.061 ***	0.088 ***	0.127 ***
# Observations		5,740	5,745	5,745	5,748	5,753

[^] Mobility includes getting out of bed or chair, going outside or moving around house.

[++] help entails human assistance or device use.

* p < .05, ** p < .01, *** p < .001

TABLE 7: First difference models:

Effects of a change in device use and other factors on the change in participation for those with mobility problems^

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Uses Assistive Device *(ATD)*					
Cane	-0.008	-0.017	-0.019	-0.008	-0.032 *
Walker	0.044	-0.056 *	-0.047 *	0.018	-0.019
Wheelchair	-0.014	-0.060 *	-0.030	-0.043	-0.001
Scooter	-0.062	0.053	0.085 *	0.088	0.070 *
Barrier Prevents Participation *(Barrier)*					
Health Prevents	-0.056 **	-0.071 ***	0.001	-0.139 ***	-0.005
Transport. Prevents	0.027	-0.095 ***	-0.041	0.044	n/a
Finds Activity Important *(Interest)*					
Finds Important	0.143 ***	0.130 ***	0.203 ***	0.165 ***	n/a
Social Support Factors *(SocSup)*					
Married	0.004	-0.098	-0.053	-0.022	-0.034
Has noone to talk to	-0.073 ***	-0.057	-0.011	0.004	0.061 *
Community Knows Each Other Well					
Agrees	0.017	0.001	0.002	0.033 *	-0.002
Community Helps each other					
Agrees	-0.012	0.010	-0.001	-0.001	-0.017
Community Can be trusted					
Agrees	-0.001	0.006	0.012	0.007	0.001
Avg. hours care/mo.	0.007 **	0.000	0.000	0.002	0.000
# Observations	2,116	2,119	2,124	2,124	2,128

^ Mobility includes getting out of bed or chair, going outside or moving around house.

*p < .05, **p < .01, ***p < .001. n/a is not asked of this activity

Note: The following categories were omitted because of no within-group variance: Children, Male, Race/Ethnicity, Highest Education & Income

TABLE 7: First difference models (continued):

Effects of a change in device use and other factors on the change in participation for those with mobility problems^

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Problem performing without help ^^ *(ADL)*					
Vision	0.056	0.035	0.046	0.065	0.032
Hearing	-0.012	-0.025	-0.035	-0.042	0.046 *
Eating	-0.023	-0.004	-0.001	-0.010	0.007
Bathing	0.009	-0.009	-0.038 *	0.017	-0.031
Toileting	0.017	0.015	-0.003	0.005	0.037 *
Dressing	-0.015	0.040 *	-0.008	-0.047 *	-0.030 *
Environmental Factors *(Environ)*					
Living in Resid. Care	-0.067	0.175 **	0.271 ***	-0.116	0.027
Age	0.003	0.001	0.003	-0.002	0.005
Diag. with Dementia	0.089	-0.007	0.078	-0.007	-0.019
Self-reported Current Health (poor ref.)					
Good	0.003	0.010	-0.010	0.013	0.005
Works for Pay	0.017	0.028	0.012	0.169 ***	-0.039
Still Drives	0.013	0.071 *	0.123 ***	0.064	0.083 ***
# Observations	2,116	2,119	2,124	2,124	2,128

^ Mobility includes getting out of bed or chair, going outside or moving around house.

^^ help entails human assistance or device use.

* p < .05, ** p < .01, *** p < .001.

Note: The following categories were omitted because of no within-group variance: Children, Male, Race/Ethnicity, Highest Education & Income

TABLE 8: First difference models:

Effects of a change in device use and other factors on the change in participation for those with sensory problems

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Use Assistive Device *(ATD)*					
Any Vision Device	-0.039	-0.037	0.004	0.081 *	0.015
Any Hearing Device	-0.008	0.022	-0.042	0.043	0.004
Barrier Prevents Participation *(Barrier)*					
Health Prevents	-0.050 **	-0.062 ***	-0.013	-0.142 ***	-0.016
Transport. Prevents	0.032	-0.106 ***	-0.081 **	0.010	n/a
Finds Activity Important *(Interest)*					
Finds Important	0.116 ***	0.144 ***	0.242 ***	0.150 ***	n/a
Social Support Factors *(SocSup)*					
Married	-0.010	-0.035	-0.063	-0.030	0.015
Has noone to talk to	-0.052 *	-0.014	-0.030	-0.008	0.006
Community Knows Each Other Well					
Agrees	0.014	0.004	0.000	-0.001	-0.002
Community Helps each other					
Agrees	-0.006	0.007	-0.009	0.016	-0.008
Community Can be trusted					
Agrees	-0.001	0.000	0.010	-0.001	0.001
Avg. hours care/mo.	0.007 ***	0.000	0.000	0.001	0.000
# Observations	4,929	4,926	4,934	4,934	4,940

* p < .05, ** p < .01, *** p < .001. n/a is not asked for this activity.

Note: The following categories were omitted because of no within-group variance: Children, Male, Race/Ethnicity, Highest Education & Income

TABLE 8: First difference models (continued):

Effects of a change in device use and other factors on the change in participation for those with sensory problems

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Problem performing without help ^^ *(ADL)*					
Mobility ^	-0.018	-0.015	-0.020	0.020	-0.043 **
Eating	-0.018	-0.013	0.000	0.005	0.028
Bathing	0.009	-0.014	-0.017	0.003	-0.022
Toileting	0.005	0.001	-0.013	-0.006	0.002
Dressing	-0.004	0.028 *	-0.017	-0.030	-0.037 *
Environmental Factors *(Environ)*					
Living in Resid. Car	-0.037	0.122 **	0.216 ***	-0.093	0.069
Age	0.000	-0.002	-0.001	0.000	-0.002
Diag. with Dementia	0.048	-0.032	0.022	-0.035	-0.033
Self-reported Current Health (poor ref.)					
Good	0.006	0.010	-0.002	0.015	0.007
Works for Pay	-0.025	0.001	0.020	0.035	0.012
Still Drives	0.024	0.097 ***	0.087 ***	0.053 *	0.074 **
# Observations	4,929	4,926	4,934	4,934	4,940

^ Mobility includes getting out of bed or chair, going outside or moving around house.

^^ help entails human assistance or device use.

* p < .05, ** p < .01, *** p < .001.

Note: The following categories were omitted because of no within-group variance: Children, Male, Race/Ethnicity, Highest Education & Income

TABLE 9: First difference models:

Effects of a change in device use and other factors on the change in participation for those with ADL problems

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Uses Assistive Device *(ATD)*					
Any Eating Device	-0.056	0.036	0.042	-0.051	-0.052
Any Bathing Device	0.010	-0.018	0.010	0.003	0.021
Any Toileting Device	0.002	0.029	-0.011	-0.006	0.023
Any Dressing Device	-0.002	-0.052 *	-0.001	-0.008	-0.030
Barrier Prevents Participation *(Barrier)*					
Health Prevents	-0.061 **	-0.068 ***	-0.022	-0.142 ***	-0.006
Transport. Prevents	0.010	-0.085 **	-0.044	0.016	n/a
Finds Activity Important *(Interest)*					
Finds Important	0.122 ***	0.122 ***	0.210 ***	0.151 ***	n/a
Social Support Factors *(SocSup)*					
Married	0.040	-0.067	0.008	-0.007	-0.013
Has noone to talk to	-0.060	-0.029	-0.019	0.014	0.027
Community Knows Each Other Well					
Agrees	0.012	-0.011	-0.005	0.008	-0.010
Community Helps each other					
Agrees	0.008	0.020	0.008	-0.002	-0.017
Community Can be trusted					
Agrees	-0.004	-0.004	0.012	0.004	0.000
Avg. hours care/mo.	0.007 **	0.000	0.000	0.001	0.000
Problem performing without help ^^ *(ADL)*					
Mobility ^	0.002	-0.017	-0.041 *	0.034	-0.045 *
Vision	0.048	0.034	-0.003	0.038	-0.008
Hearing	-0.028	-0.028	-0.024	-0.034	0.048
# Observation	2,708	2,712	2,712	2,714	2,718

*p < .05, **p < .01, ***p < .001. n/a is not asked for this activity.

Note: The following categories were omitted because of no within-group variance: Children, Male, Race/Ethnicity, Highest Education & Income

TABLE 9: First difference models (continued):

Effects of a change in device use and other factors on the change in participation for those with ADL problems

	Participation Activity				
	Visit	Rel. Serv.	Join Clubs	Out Enjoy	Volun.
Environmental Factors *(Environ)*					
Living in Resid. Care	-0.031	0.126 *	0.204 ***	-0.127 *	0.025
Age	0.002	-0.004	-0.001	0.006	0.006
Diag. with Dementia	0.068	-0.031	0.091	-0.046	-0.048
Self-reported Current Health (poor ref.)					
Good	-0.005	0.006	-0.009	0.016	0.009
Works for Pay	-0.022	0.023	0.013	0.066	0.000
Still Drives	0.011	0.090 ***	0.102 ***	0.059	0.073 **
# Observations	2,708	2,712	2,712	2,714	2,718

^ Mobility includes getting out of bed or chair, going outside or moving around house.

^^ help entails human assistance or device use.

* p < .05, ** p < .01, *** p < .001

Note: The following categories were omitted because of no within-group variance: Children, Male, Race/Ethnicity, Highest Education & Income

APPENDIX A
2012 Estimate and 2015 to 2060 Projections of the Population
of the United States by Selected Age Groups

Resident Populations as of July 1, Numbers in thousands

	2012	2015	2020	2025	2030	2035
Total All Ages	**313,914**	**321,363**	**333,896**	**346,407**	**358,471**	**369,662**
Under 5 years	19,999	21,051	21,808	22,115	22,252	22,516
Under 18 years	73,728	74,518	76,159	78,190	80,348	81,509
5 to 13 years	37,009	36,772	37,769	39,511	40,366	40,790
14 to 17 years	16,719	16,695	16,582	16,565	17,730	18,203
18 to 64 years	197,041	199,150	201,768	203,166	205,349	210,838
18 to 24 years	31,360	30,983	30,028	30,180	30,605	32,125
25 to 44 years	82,826	84,327	88,501	91,833	93,878	95,013
45 to 64 years	82,855	83,839	83,238	81,152	80,865	83,700
65 years and over	43,145	47,695	55,969	65,052	72,774	77,315
85 years and over	5,887	6,306	6,693	7,389	8,946	11,579
100 years and over		78	106	143	168	188

	2040	2045	2050	2055	2060
Total All Ages	**380,016**	**389,934**	**399,803**	**409,873**	**420,268**
Under 5 years	23,004	23,591	24,115	24,479	24,748
Under 18 years	82,621	84,084	85,918	87,744	89,288
5 to 13 years	41,190	41,936	42,951	43,969	44,758
14 to 17 years	18,427	18,558	18,852	19,296	19,782
18 to 64 years	217,675	224,562	230,147	234,819	238,947
18 to 24 years	33,199	33,680	33,967	34,469	35,239
25 to 44 years	96,078	98,725	101,609	104,331	106,303
45 to 64 years	88,398	92,157	94,570	96,020	97,404
65 years and over	79,719	81,288	83,739	87,309	92,033
85 years and over	14,115	16,512	17,978	18,201	18,187
100 years and over	230	310	442	564	690

Source: U.S. Census Bureau, Population Division

2012 Annual Estimates of the Resident Population for Selected Age Groups and Sex for the United States: Released June 2013

2015 - 2060 Projections of the Population by Selected Age Groups and Sex and Sex for the United States (NP2012-T2): Released December 2012

APPENDIX B
THE ICF: A NEW PARADIGM OF DISABILITY

As a person ages, physical limitations often inhibit his or her ability to function. The individual may become unable to perform activities of daily living (ADLs) or instrumental activities of daily living (IADLs), and may disengage from society putting them at greater risk of isolation. In the past these limitations may have led to the person being described as disabled. In 2001 the World Health Organization (WHO) developed the International Classification of Functioning, Disability & Health Framework (ICF) to provide a standardized language to define and measure health and disability within a new paradigm (World Health Organization, 2001). In the ICF, disability is not construed simply as a medical problem "correctible" only through professional treatment, nor is it merely a socially created problem unattributed to the individual, but rather disability is described in a biopsychosocial model that synthesizes the concepts of both the medical and social models of disability (World Health Organization, 2002). Disability is an interaction between features of the person and the overall context in which the person lives, therefore some aspects are almost entirely internal to the person, while others are almost entirely external. Drawing attention to the importance of one's environmental context in determining limits on activities and restrictions on participation is one of the strengths of the ICF (Wade & Halligan, 2003). These environmental factors can act as limiting barriers (such as transportation problems) or facilitators (like social networks or personal caregiving) to effect physical ability and activity participation. The following diagram is one representation of the model of disability that is the basis for the ICF.

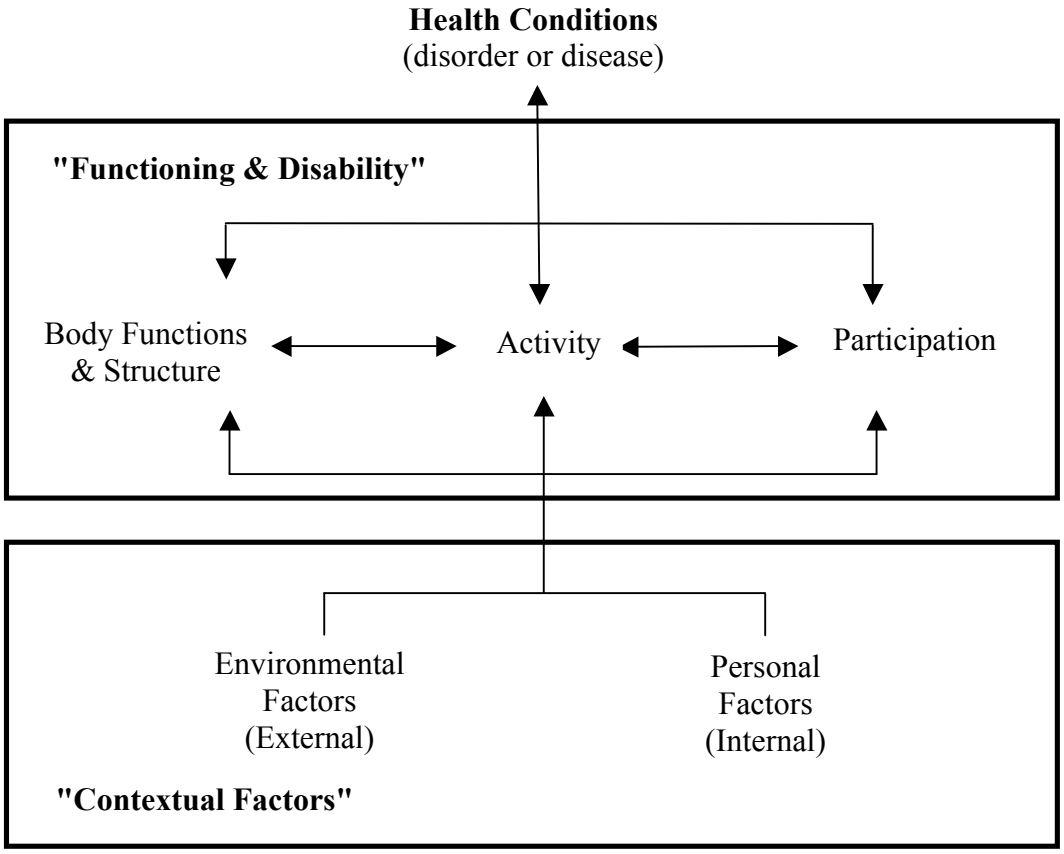

Figure 1 Model of Disability for the ICF
World Health Organization, 2002

The ICF framework consists of two domains as outlined in bold above. The components of the first encompass the domain of Functioning and Disability with "Functioning" used as the umbrella term referring to all bodily functions and structures, activities and participation and "Disability" indicating the level of *impairment* of functioning, *limitations* on activities and *restriction* of participation. The second domain consists of the internal and external Contextual Factors which will be described below. As can be seen in the previous diagram, in the ICF Functioning and Disability are viewed as outcomes of interactions between both underlying health conditions and the second domain, Contextual Factors.

Body functions are the physiological functions of body systems and would include functions such as seeing, feeling pain and remembering. **Body structures** are the associated anatomical parts of the body such as the eye, a hand or the brain. Impairments in functioning would be described as significant detriment to body function or body structure, such as loss of vision or a detached retina.

Activities refer to the execution of a task or an action by an individual and **participation** to one's involvement in a life situation. It is interesting to note that in earlier classifications being unable to perform a task was called a "disability," but in the ICF it is now referred to as a "limitation on activities performed." For example, a person may have difficulty walking under normal circumstances, but may be able to walk slowly with a cane. The loss of body function therefore does not mean that person is disabled, merely limited in his functionality.

Environmental Factors are those physical and social factors that the individual operates within, including the physical environment, communication and other assistive devices, any personal care they receive and the support network available. It also entails societal level items such as transportation and education systems, governmental agencies, and laws and regulations.

Personal Factors are distinct from one's health condition and include such things as gender, age, race/ethnicity and education. Although not explicitly coded in the application of the ICF, these items are included as context in the framework.

The bottom line is that disability is no longer considered merely a function of one's health conditions, but also of the contextual factors which may act either as facilitators of or barriers to improved mobility and sensory functioning. This ability or

inability to function may, in turn, determine one's ability to perform the activities that would allow one to participate in civic, religious, or family events. According to the WHO the aim of rehabilitation should be to maximize function and minimize limitation of activity and restriction on participation resulting from an underlying impairment. Assistive Technology Devices are designed for just that purpose.