Functional disability and diabetes among Latin American and Caribbean elders

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Introduction

In the last fifty years, life expectancy at birth in Latin America has increased from 52 years to near 72 years and further increases are expected in the next decades (CELADE 2004). Moreover, the elderly population is growing faster than younger age groups and, as a consequence, the percentage of those aged 65 and over is expected to rise from the current 5.5% to 10% in 2025 (CELADE 2004). Therefore, one of the main concerns nowadays is whether such increases in life expectancy imply better health for this larger surviving aging population.

Along with the demographic transition, epidemiological and nutritional transitions are in progress. Non-communicable diseases are becoming increasingly more important and obesity is on the rise in Latin America and the Caribbean. One of the fastest growing diseases in the region is diabetes. In 1995, the prevalence rate was estimated to be 5.7% and it is expected to reach 8.1% in 2025 – a 42% increase. The number of cases in Latin America will rise from 15 million in 1995 to 39 million in 2025 (King et al. 1998), with Brazil and Mexico comprising over 50% of the cases in both years.

Because diabetes prevalence rises with age, the impact of diabetes on disability is likely to be particularly significant in an aging population. There is great concern that the burden of the disease will increase in the next decades and that the quality of life of those with the disease will be reduced. Physical disability, loss of independence, and worse quality of life are constant threats for those with the disease.

Most of the studies analyzing the relationship between diabetes and physical limitations come from developed countries and very little is known about this association in developing countries. In developing countries, individuals are more exposed to diseases and malnutrition during childhood, which makes them frailer and, probably, more disabled. In addition, access to health care is more precarious and diseases tend to be diagnosed later when complications are more prevalent. Therefore, it is expected that individuals in poorer countries (and with lower socioeconomic conditions) will be more disabled.

In recent years, new surveys were conducted in Latin America and the Caribbean, which provide a unique opportunity to explore the disability burden associated to diabetes in the region. Two datasets are particularly important: Salud, Bienestar y Envejecimiento en América Latina y el Caribe Proyecto (SABE) and Mexican Health and Aging Study (MHAS). Data is available for many countries in the region, allowing us to deal with different stages of the epidemiological and demographic transitions. This is particularly important because prevalence levels of disability tend to be lower in the initial stages of the epidemiological transition and it increases as the transition advances (Myers et al. 2003). Most of the available data is cross-sectional, which provides useful information on disability prevalence, as well as on prevalence of diabetes and comorbidities. Availability of panel data is even more limited. An important exception is Mexico, where panel data from MHAS provide a unique opportunity to analyze disability status transitions among diabetics and nondiabetics.

The main hypothesis of this paper is that diabetes is likely to impose an important burden on those with the condition. This burden is characterized by a higher prevalence and incidence of functional disability among those with diabetes. More specifically, this paper aims to explore the following specific hypotheses:

♦ The odds of functional disability and limitations on instrumental and basic activities of daily living are significantly higher in individuals with diabetes.

♦ Individuals with diabetes at baseline are more likely to become functionally disabled and to develop difficulties performing instrumental and basic activities of daily living.

♦ Those with diabetes at baseline are less likely to recover from disability.

♦ Individuals who have diabetes at baseline have worse outcomes (incidence of comorbid conditions and mortality) than non-diabetics at the baseline.

Since diabetes is often associated with other comorbid conditions, it is necessary to relate functional disability to the underlying diseases implicated. One way of doing this is by investigating the statistical associations between diabetes and disabilities, controlling for other comorbid conditions related and non-related to diabetes. Therefore, this analysis will also determine the extent to which disability is mediated by selected health conditions (heart disease, stroke, high blood pressure, lung disease and arthritis). Using panel data from Mexico, this work will also explore the role of diabetes itself and other comorbidities on disability incidence and transitions between health states.

These hypotheses have been tested mainly in developed countries, therefore the availability of these two recent surveys from seven countries in Latin America and the Caribbean provide a unique opportunity to understand the diabetes burden in a setting in which diabetes prevalence rates are expected to rise fast. The analysis will try to measure the impact of diabetes per se, but this is a difficult exercise because diabetes is frequently associated with other disabling comorbidities. In all analyses, I will present the 'upper bound' estimate of the diabetes burden when considering that all the burden comes from diabetes, and a 'lower bound', in which other comorbidities will be included in the model.

Diabetes and disability

Diabetes is associated with other medical complications, such as cardiovascular disease, stroke, vision impairment, neuropathy and peripheral vascular disease. Usually, functional disability among diabetics is thought to be a consequence of these medical conditions (Gregg et al. 2000, Gregg et al. 2002, Volpato et al. 2002, Egede 2004, Maty et al. 2004). Some comorbidities are intrinsically associated with diabetes, such as hyperglycemia and obesity, others are commonly recognized as complications of it, such as chronic heart disease (CHD). Finally, other less commonly recognized factors that might be associated with diabetes such as depression and arthritis may also play a role (Gregg et al. 2002). Another hypothesis is that diabetes, and the metabolic syndrome, represent a more general underlying disorder related to inflammatory system alterations that potentially affects multiple physiological systems (Pickup et al. 1997, Barzilai et al. 2001, Pickup 2004). In any case, there is evidence that diabetes itself, associated comorbidities, consequent functional and cognitive limitations influence quality of life and mortality.

Limitations in basic and instrumental activities of daily living performance have a great impact on personal independence, on their quality of life, and the well-being of their families. Diabetes has been shown to be strongly associated with physical limitation and functional disability (Gregg et al. 2000, Valderrama-Gama et al. 2002, Bruce et al. 2003, Ryerson et al. 2003, Maty et al. 2004). In general, individuals with diabetes are about two to three times more likely to have disability than those without (Gregg et al. 2000, Gregg et al. 2002, Ryerson et al. 2003). For instance, Gregg et al. (2000) compares the ability of elderly individuals to walk one-fourth of a mile, climbing 10 steps without resting, or do housework. They find that diabetic women are 2.7 times more likely to be unable to perform the 3 activities than their non-diabetic counterparts, while odds-ratio reaches 3.62 among men after controlling for age, ethnicity, education and BMI. However, differentials in disability prevalence decrease with age (Ryerson et al. 2003).

Those with diabetes are also more likely to become functionally disabled (Gregg et al. 2002). Gregg et al. (2002) report a yearly incidence of 9.8% among women with diabetes and

4.8% among non-diabetics. After controlling for comorbidities and potential confounders, diabetes is still associated with an increase of 42% in the risk of any incident disability (Gregg et al. 2002). Moreover, Jagger et al. (2003) show that those with diabetes experience a lower likelihood of recovery from inactive to active, although the differential diminishes with age.

Physical disability also increases with diabetes duration and those making use of insulin are more likely to report disabilities (Gregg et al. 2000). For instance, Gregg et al. (2000) show that insulin-dependent women are 3.29 times more likely to have physical disability than their non-diabetic counterparts. Among men, the odds-ratio is 2.89 (Gregg et al. 2000).

Diabetes and metabolic syndrome are also associated with cognitive dysfunction (Sinclair et al. 2000, Yaffe et al. 2004) and cognitive impairment is more likely to develop among those with high level of inflammation (Yaffe et al. 2004).

Given the higher morbidity and disability associated with diabetes, those with the condition have lower life expectancy than those without diabetes, and they also spend fewer years active than those without diabetes (Jagger et al. 2003).

Excess mortality associated with diabetes

Individuals with diabetes face higher mortality risks. However, there is some evidence that excess mortality declines with age (Waugh et al. 1989, Walters et al. 1994, Berger, Stenström and Sundkvist 1999, Gu, Cowie and Harris 1999, Bertoni et al. 2002), even though absolute excess mortality increases with age (Roper et al. 2002). Large part of this mortality differential is explained by a higher mortality due to cardiovascular diseases among diabetics, particularly ischemic heart disease (Waugh et al. 1989, Wei et al. 1998, Gu, Cowie and Harris 1999, Biderman et al. 2000, Brun et al. 2000, de Vegt et al. 2000, Morrish et al. 2001, Roper et al. 2001). Excess mortality is higher among insulin-treated patients than among patients treated orally or by diet (Head and Fuller 1990, Walters et al. 1994, de Marco et al. 1999, Morrish et al. 2001, Roper et al. 2001, Gnavi et al. 2004). Excess mortality also increases with diabetes duration (Brun et al. 2000). Bertoni et al. (2002) analyzed a sample of elderly individuals in the U.S. and found an overall standardized mortality ratio (SMR) of 1.41. This ratio was very similar to the one reported by the Verona Diabetes study, in which the SMR for all causes of death was 1.42 (Marco et al. 1999), while in Turin SMR was about 1.43 among those with type 2 diabetes (Gnavi et al. 2004). In United Kingdom, standard mean ratio for the diabetic population was 1.24 (Morgan, Currie and Peters 2000), while Roper et al. (2001) report higher SMR: 1.71 for females and 1.59 for males with type 2 diabetes. For those with type 1, SMR are considerably higher: 7.22 and 3.40, respectively. In Netherlands, SMR ratios reached 3.83 for those with known diabetes and 1.56 for newly diagnosed diabetics under ADA criteria (de Vegt et al. 2000). Morrish et al (2001) report SMR for 10 centers around the world. SMR are considerably higher than 100, ranging from 138 in Tokyo to 370 in Havana for those with type 2 diabetes. Those with type 1 diabetes face even higher mortality risks – the SMR ranged from 188 in London to 685 in Havana (Morrish et al. 2001). In Brazil, all-cause SMR was 3.36 among those with type 2 diabetes (Salles, Bloch and Cardoso 2004). In Taiwan, all-cause SMR reaches 1.63 (Tseng 2004). Given higher mortality rates, diabetics are expected to live shorter lives than non-diabetics. For those aged 65-74, life expectancy is 4 years lower among diabetics (Gu, Cowie and Harris 1999). However, there is evidence that age at death is increasing among diabetics in some settings (Berger, Stenström and Sundkvist 1999).

In some studies, women with diabetes faced higher excess mortality than men. Bertoni et al. (2002) report a SMR of 1.44 for women and 1.37 for men, while Morgan, Currie and Peters (2000) find 1.35 and 1.15, respectively. However, other studies have found that diabetic men face higher excess mortality than women. In Israel, SMR are higher among men than women – 1.85 and 1.27, respectively (Biderman et al. 2000). Gu, Cowie and Harris (1998) also found a higher mortality among men in the United States. Men in Taiwan also face higher mortality than women (Tseng 2004). Finally, other studies have found no statistical difference between diabetic males and females in Sweden (Berger, Stenström and Sundkvist 1999).

Diabetes risk factors, as obesity, are also associated with higher mortality. For instance, Peeters et al. (2003) have shown that obesity at age 30 to 49 decreases life expectancy, on average, in about 6 years.

Data sources, measures and statistical models

Data sources

- **Salud, Bienestar y Envejecimiento en América Latina y el Caribe Proyecto (SABE)**

Data from SABE contain information on 10,602 individuals aged 60 and over in seven large urban areas in Latin America and the Caribbean. Of those, there were 57 individuals that did not report their diabetic status (0.5%). Among the remaining 10,545 cases with information on their diabetes status, 1,763 reported having a positive diagnose for diabetes at some point in life (16.7%).

SABE has information on several health indicators, including self-assessment of health status. Individuals were asked if a doctor has ever told them if they had: hypertension, diabetes, cancer (excluding minor skin cancer), lung disease, heart disease, stroke, and arthritis. Other health problems such as falls, fractures (including hip fracture), urinary and fecal incontinence, osteoporosis, visual impairment and hearing problems were also investigated.

For those answering that have been diagnosed with diabetes, additional questions on use of oral medication, insulin injections, and diet we made. Individuals were also asked whether their diabetes has gotten better, worse or the same in the last year.

SABE also has important data on anthropometric measures, such as weight, height, waist circumference, waist-to-hip ratio, among others were obtained by paramedical personnel specially trained for this study.

Regarding activities of daily living (ADL), SABE has information on the following items: dressing, bathing, eating, getting in and out of bed, toileting and walking across a room. Individuals were given the following introduction: “Here are a few everyday activities. Please tell me if you have any difficulty with these because OF A HEALTH PROBLEM. Exclude any difficulties you expect to last less than three months”. After this introduction they were asked “Do you have difficulty …?” and the possible answers were: ‘yes’, ‘no’, ‘does not know’ and ‘no response’. For the items – walking across a room, bathing, getting in an out of bed, and using the toilet - additional questions regarding use of equipment or devices to help performing the activity were made. For all items, respondents were asked if anyone provides help. Again, the possible answers were ‘yes’, ‘no’, ‘does not know’ and ‘no response’. Those answering “does not know” were classified as missing.

Questions about the instrumental activities of daily living (IADL) followed the ADL questions. No additional introduction was made. Individuals were asked “Do you have difficulty…?” The IADL items were: preparing a hot meal, managing your own money, going to places alone (like to places such as the doctor, church, etc), shopping for groceries, making telephone calls, taking medication, doing light and heavy housework. The possible answers were: ‘yes’, ‘no’, ‘cannot do it’, ‘does not do it’, ‘does not know’ and ‘no response’.

Subsequently, they were asked whether someone helps them perform the activity. Those who answered “cannot do it” were classified as having difficulty performing the activity, while those answering “does not do it” were classified as not having difficulty.

SABE also contains data that allow the use of NAGI scale. The NAGI scale is a measure of physical performance. The selected NAGI items included are: difficulty pushing or pulling heavy objects, stooping (crouching or kneeling), handling small objects (such as small coin), reaching or extending arms above shoulder level, and lifting or carrying objects over 10 pounds. Individuals were asked first these items and then the ADL and IADL items. Before they were asked directly about each activity, the interviewer introduced “We need to know about problems that people may have doing certain activities that are important to daily living BECAUSE OF A HEALTH OR PHYSICAL PROBLEM. Please tell me whether you have (at this time) any difficulty doing any of the activities that I am going to mention. EXCLUDE ANY DIFFICULTIES THAT YOU EXPECT TO LAST LESS THAN THREE MONTHS”. After this introduction, they were asked “Do you have any difficulty…?”. The possible answers were: ‘yes’, ‘no’, ‘cannot do it’, ‘does not do it’, and ‘no response’. Those who answered “cannot do it’ and ‘does not do it’ were classified as having difficulty performing the activity.

- **Mexican Health and Aging Study (MHAS)**

In the first wave, conducted in 2001, the response rate reached 90.1%, 89.2 and among targets and 97.2% for spouses. A total of 15,144 complete interviews were obtained. A direct interview was sought with each individual, and proxy interviews were obtained when poor health or temporary absence precluded a direct interview. The final sample is composed by 13,081 individuals aged 50 and over with complete information on age, sex and diabetic status. There are 7,150 individuals aged 60 and over with complete information on these three variables. In the second wave: 13,497 individuals were alive and completed the interview, among those 6,978 individuals aged 60 and over with complete information on age, sex and diabetic status in both waves were included in the final analysis.

Of particular interest, MHAS includes measures of health and disability. In the core questionnaire, individuals were asked to provide information on self-assessment of health status. Individuals were also asked if a doctor has ever told them if they had: hypertension, diabetes, cancer (excluding minor skin cancer), respiratory problems, heart disease, stroke, and arthritis. For those answering having being diagnosed with diabetes, additional questions on use of oral medication, insulin injections, and diet we made. Other health problems such as liver or kidney infection, tuberculosis, pneumonia, falls, pain, vision and hearing problems were also investigated. In the second wave, for those individuals who had participated in the first wave, the question inquired whether a doctor had diagnosed those health conditions in the last two years.

Yet in the core questionnaire, respondents informed about possible limitations on NAGI functions, ADL and IADL measures. In this section of the questionnaire, the questions were the same in 2001 and 2003.

Functional limitations where introduced by interviewers using the following sentence "Please tell me if you have any difficulty in doing each of the daily activities that I am going to read. Don't include difficulties that you believe will last less than three months". After this introduction, respondents were asked "Because of a health problem, do you have difficulty with…?". The selected items covered the following dimensions: pushing or pulling large objects (such as a living room chair), stooping (kneeling or crouching), handling small objects (such as small coin), reaching or extending arms above shoulder level, and lifting or carrying objects over 5 kilos (approximately 11.02 pounds).

Before asking the ADL questions the interviewers made the following introduction "Please tell me if you have *any* difficulty with each of the activities I mention. If you do not do any of the following activities, simply tell me. Do not include difficulties that you believe will last less than three months (italics by the author)". After this introduction, respondents were asked "Because of a health problem, do you have any difficulty …?". The following ADL items were investigated: walking across a room, bathing or showering, eating, getting into or out of the bed, and toileting. The possible answers were: 'yes', 'no', 'can't do it', 'does not do it', 'does not know' and 'refusal'. The information about dressing was made before this set of questions. The information was asked for all individuals with the following wording "Because of a health problem, do you have difficulty with dressing including putting on shoes and socks?". For walking and transferring (getting into or out of bed) additional questions regarding use of equipment or devices to help performing the activity were made. For all items, respondents were asked if anyone else ever provided any help. For those married, respondents were asked if spouse help the respondent walking, bathing, eating, transferring or using the toilet. The possible answers were 'yes', 'no', 'do not know' and 'refusal'. All ADL questions, except dressing, were only asked for those with NAGI limitations. The survey assumed that those without functional limitation would not have any difficulty on basic activities of daily living.

Questions regarding difficulties performing instrumental activities of daily living were introduced by the following sentence: "Now I am going to mention other activities. Please tell me if you have any difficulty with the activities that I mention to you. If you do not do any of the following activities, simply tell me. Do not include difficulties that you believe will last less than three months". Then, respondents were asked "Because of a health problem, do you have any difficulty...?". IADL items included: preparing a hot meal, managing own money, shopping for groceries, and taking medication. Possible answers were: ‘yes’, ‘no’, ‘can’t do it’, ‘doesn’t do it’, ‘does not know’ and ‘refusal’. Those who answered ‘cannot do it’ and ‘does not do it’ for the IADL questions were reclassified as having difficulty performing the activity if they had answered later that this limitation was due to a health problem. However, if they answered that they were unwilling or unable to perform these activities, but not due to a health problem, they were considered as not having difficulty performing it.

Finally, information on whether spouse or someone else ever helped them performing the activity was also collected. For the proxy respondents’ questionnaire, there were no questions regarding difficulties performing IADL activities or self-assessment of health status.

In the second wave, interviews were made with the kin of deceased participants of the first wave. Next kin were asked to inform about age and data of death, primary sickness that caused death (cancer, diabetes, stroke, heart, or another health problem), and about health problems that were diagnosed in the last months of life (hypertension, diabetes, cancer, heart and pulmonary problems, liver or kidney infection, tuberculosis, pneumonia, another condition affecting memory, falls and pain). Next kin respondents also provided information on whether the deceased needed help with at least one of the following ADL activities: walking across the room, bathing, eating, getting in and out of the bed, and toileting. Possible answer was: ‘yes’, ‘no’, ‘couldn’t do those activities’, and ‘didn’t do those activities’.

Finally, MHAS contains anthropometric measures for a random subsample of 20% of the respondents. Interviewers measured weight, height; waist, hip, and calf circumference, and knee length.

Measures

Six activities were considered in the activities of daily living (ADL) measure: dressing, bathing, eating, getting in and out of a bed (transferring), toileting, and getting across the room. In MHAS, those who did not declare having NAGI limitations were assumed to do not have ADL limitations. Four instrumental activities of daily living (IADL) were included in the final analysis: preparing a hot meal, money management, shopping, and taking medication. The NAGI physical performance measure included: lifting or carrying objects weighted 5 Kg or over, lifting up a coin (using fingers to grasp or handle), pulling or pushing a large object such as a living room chair, stooping, kneeling or crouching, and reaching or extending arms above shoulder level.

ADL, IADL and NAGI were measured in three different ways: 1) binary form, in which those scoring ‘0’ indicate that they do not have any limitations, while score ‘1’ was assigned for those who have reported having difficulty performing at least one activity; 2) binary form that assess severity in which those scoring ‘0’ reported having difficulty performing none or less than 3 ADL, IADL, or NAGI activities, respectively, while score ‘1’ was assigned for those reporting having difficulties performing 3 or more activities and 3) the conditions were summed creating a summary score ranging from ‘0’ to ‘6’ in the case of ADL scale, from ‘0’ to ‘4’ in the IADL score, and from ‘0’ to ‘5’. In each scale the score ‘0’ represents the ability to independently perform all activities.

Measures on SABE and MHAS seem to be quite comparable, as both impose the same minimal duration in defining disability (3 months). They also stress that disability is due to a health problem. The main difference refers to the fact that ADL questions in MHAS were only done for those with physical limitation. Other wording variations may also play a role. Another important difference is the answering categories.

Table 1 shows the results for the item response and missing data in SABE and MHAS. Missing data in SABE is very small, as well as those who refused to answer or didn’t know how to answer it. In MHAS, the high proportion of missing data on 5 activities of ADL comes from the fact that these questions were skipped when individuals did not report physical functional limitations earlier in the questionnaire. As mentioned before, later adjustments were made and those with missing data due to this skip pattern were considered without having ADL if they did not report any difficulty on NAGI items. As for IADL and NAGI items, missing data on MHAS was considerably higher than in SABE. Those who answered “do not know” and those who refused to answer, where treated as missing data in both datasets. There was no attempt to impute the missing data.

Table 1: ADL, IADL and NAGI item response and missing data, SABE and MHAS 2001 – individuals aged 60 and over and with complete information on diabetic status

	Yes	No	Can't do it	Doesn't do it	Refusal	DK	Missing
SABE (N=10,545)							
ADL							
Bathing	8.4	91.2	0.0	0.0	0.1	0.1	0.1
Dressing	11.8	88.1	0.0	0.0	0.0	0.0	0.1
Eating	4.3	95.5	0.0	0.0	0.0	0.0	0.1
Transferring	9.8	89.9	0.0	0.0	0.0	0.1	0.1
Toileting	5.0	94.8	0.0	0.0	0.0	0.1	0.2
Walking room	7.3	92.5	0.0	0.0	0.0	0.0	0.1
IADL							
Hot meal	4.1	80.5	1.6	13.7	0.0	0.0	0.1
Money	8.4	74.9	2.3	14.2	0.0	0.0	0.2
Shopping	7.1	84.6	0.8	7.2	0.0	0.0	0.2
Medication	5.6	90.0	1.1	3.2	0.0	0.0	0.1
NAGI							
Pushing	18.4	72.2	4.7	4.5	0.0	0.0	0.1
Kneeling	42.3	52.2	4.0	1.4	0.0	0.0	0.1
Arms up air	13.9	84.6	0.9	0.4	0.0	0.0	0.1
Lifting	21.8	65.5	5.6	7.0	0.0	0.0	0.1
Coordination	6.0	92.2	0.8	0.7	0.1	0.0	0.2
MHAS 2001 (N=6,978)							
ADL							
Bathing	6.2	58.6	0.3	0.0	1.0	0.2	33.6
Dressing	8.3	82.9	0.2	0.0	0.3	0.1	8.2
Eating	3.3	61.5	0.2	0.2	1.0	0.3	33.6
Transferring	7.6	57.2	0.3	0.0	1.0	0.2	33.6
Toileting	6.0	58.7	0.3	0.0	1.0	0.3	33.6
Walking room	8.4	56.3	0.4	0.1	1.0	0.2	33.6
IADL							
Hot meal	5.7	86.0	0.0	0.0	0.1	0.1	8.2
Money	9.1	82.5	0.0	0.0	0.2	0.1	8.2
Shopping	3.7	87.7	0.0	0.0	0.3	0.1	8.2
Medication	3.7	87.7	0.0	0.0	0.3	0.1	8.2
NAGI							
Pushing	24.3	64.1	0.9	2.3	0.2	0.1	8.2
Kneeling	39.8	49.9	1.2	0.8	0.1	0.1	8.2
Arms up air	13.3	78.0	0.2	0.1	0.1	0.1	8.2
Lifting	23.1	65.9	0.9	1.7	0.1	0.1	8.2
Coordination	7.3	83.9	0.2	0.2	0.2	0.1	8.2

Those who self-reported being previously diagnosed with diabetes, heart disease, stroke, arthritis and cancer were assumed to have remained with the condition in the second wave. In MHAS, there were 197 cases in which individuals who had reported in the first wave having diabetes, but reported not having the condition in the second wave. These individuals were considered as having diabetes in the second wave given the fact that 159 individuals in this condition were under special diet, use of oral medication or insulin to control their diabetes in 2001. There were 205 reclassifications for heart disease, 167 for stroke, 796 for arthritis and 93 for cancer.

Body mass index (BMI) was used to generate a weight status dummy variable for obese people. BMI was obtained dividing the individuals' weight, in kilograms, by their height in meters squared. Individuals with BMI equal or greater to 30 were assigned '1' and those with BMI under 30 were assigned "0'.

Methods

Descriptive statistics were calculated for the total sample of SABE and MHAS and then separately by country. Diabetics and nondiabetics were contrasted and significant differences in means were calculated with *t*-tests for continuous variables and chi-square for binary variables.

For the binary outcomes, logistic regressions were employed in order to test the main hypothesis that the odds of functional disability and limitations on basic and instrumental activities of daily living are higher in individuals with diabetes than among those without. Model 1 includes demographic characteristics and diabetic status, Model 2 includes the variables of Model 1 and adds the obesity dummy. Models 3 and 4 include potential confounders and several comorbidities that are associated or not with diabetes. Model 3 is an extension of Model 1 and Model 4 is an extension of Model 2. Model 4a does not include cancer.

Model 1: age, sex and diabetes status

Model 2: model 1 + obesity

Model 3: model 1+ chronic conditions

Model 4: model 2+ chronic conditions

Model 4a: do not include cancer

Cases with missing data on any of the variables included in the regression were excluded (listwise deletion). The diseases related to diabetes that included the analysis are: stroke, heart diseases and high blood pressure. Comorbid conditions that are unrelated to diabetes, but related to disability are cancer and arthritis. Cancer was included only in pooled models using SABE. Important to note that estimated results after controlling for comorbidities probably underestimates the effect of diabetes because these diseases are worsened by diabetes.

For the ADL and IADL outcomes measured in the discrete count variables form, generalized logistic regression models for ordinal dependent variables were employed. For all models, the ‘brant’ command was used to test the proportional odds assumption (also known as parallel regression assumption). When the assumption of proportionality was not reasonable for some variables, it was relaxed using the command ‘gologit2’ (Williams, 2005).

In order to test the first hypothesis, data from SABE and MHAS were used. In SABE the analysis was performed using pooled data as well data from each country. For MHAS, both waves of were pooled. In this case, panel data estimations were performed assuming random effects in the case of logistic regressions. For the ordered logistic regressions, MHAS pooled observations were considered independent across groups (clusters), but not within groups.

The remaining hypotheses require the panel data from MHAS. The second hypothesis is that those with diabetes are more likely to become functionally disabled and to develop difficulties performing instrumental and basic activities of daily living in the second wave. As mentioned before, it is expect that individuals with diabetes will be more likely to become functionally disabled and to develop difficulties performing basic and instrumental activities of daily living than those without the disease at the baseline.

The third hypothesis, which states that those with diabetes at baseline are less likely to recover from disability, will be tested using logistic regression approach. More specifically, tests will be performed to show that those with diabetes are less likely to recovery from ADL, IADL and NAGI limitations.

Finally, the last hypothesis that diabetics are also expected to have worse health outcomes (incidence of chronic conditions and higher mortality) will also be tested using the logistic regression approach.

Analysis of Descriptive Data

Table 2 confirms that those reporting having diabetes have higher prevalence of ADL, IADL and NAGI limitations. Prevalence of limitations on at least one basic activity of daily living reaches one fourth of diabetics in the SABE sample and 21% of Mexicans (non-diabetics have lower prevalence rates: 19 and 14%, respectively). Over 22% of the diabetics in the SABE sample suffer from limitations on instrumental activities of daily living - against 15% of non-diabetics. Rates reach almost 18% among Mexican diabetics and 11.4% among those without the disease. With age, it becomes increasingly more difficult to perform activities such as kneeling, crouching, lifting weight and pushing large objects. Over half of the elderly in both samples have difficulty with at least one NAGI activity. Near 70% of the diabetics in the SABE and 66% of Mexicans suffer from at least one NAGI condition, compared with 60% and 52.2% of non-diabetics, respectively. Diabetics are also more severely affected on their daily lives.

They have higher prevalence of severe ADL, IADL and NAGI limitations. Diabetics also have higher prevalence of heart disease, stroke and arthritis, which imposes additional burden on their daily lives. Finally, obesity and higher BMI values are also found among diabetics.

For each of the seven cities in Latin America and the Caribbean, those with diabetes are more likely to have difficulties performing ADL and IADL, and to have NAGI physical limitations (Table 3 and Graphs 1 to 3). However, levels of reported ADL, IADL and NAGI limitations range considerably across cities/countries. For instance, prevalence rates of ADL among diabetics range from 17.3% in Bridgetown to 34.9% in Montevideo. In terms of IADL, prevalence rates among diabetics ranged from 9% in Montevideo to 33.4% in São Paulo. Bridgetown has the lowest prevalence of NAGI limitations – 59.6%, while the highest is found in Havana (74.5%). Differences in age distributions do not explain completely these differences in the levels of ADL, IADL and NAGI report (Table 4), so other factors such as differences in self –report and in the percentage of proxy respondents may explain those differences. Also important to note, Bridgetown was the only city in which the questionnaire was administered in English. In all other cities, except São Paulo (in which the questionnaire was in Portuguese), questionnaires were in Spanish. Additional analyses will be necessary to clarify these differences.

Table 2: Demographic, anthropometric, disability measures and disease prevalence among elderly people (60+) in Latin America and the Caribbean by diabetic status, SABE and MHAS 2001

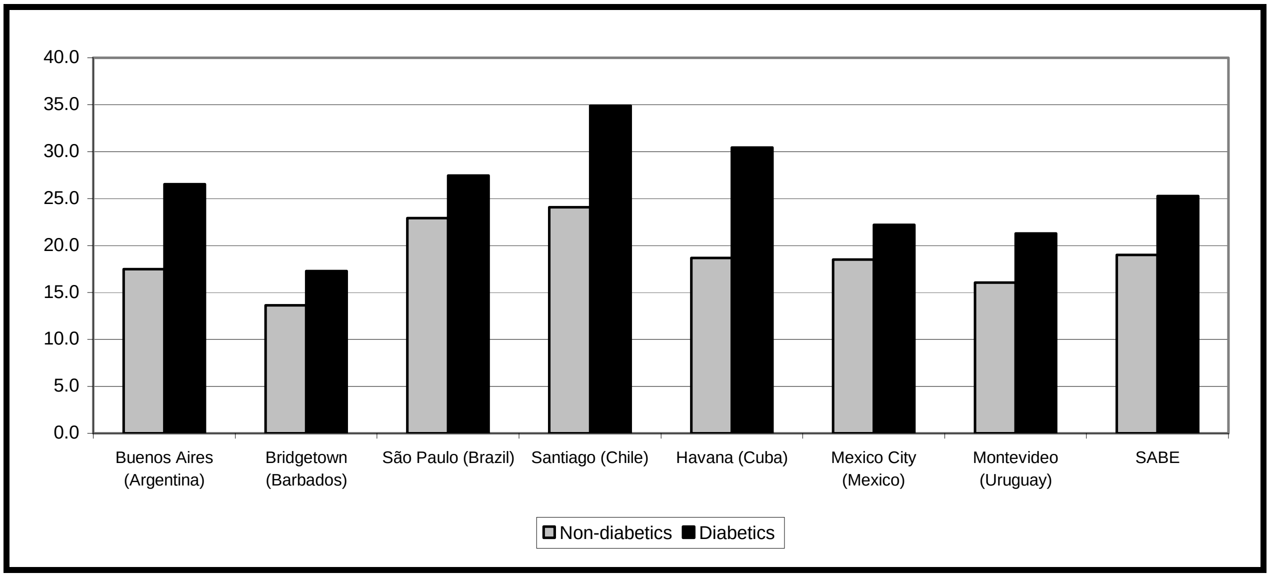
Variables	SABE			MHAS		
Percentages and means	Non-diabetics	Diabetics	p-value	Non-diabetics	Diabetics	p-value
Age (mean)	71.8	71.6	0.221	69.6	68.9	0.002
Female	61.0	66.5	0.000	52.4	60.3	0.000
ADL	19.0	25.3	0.000	13.9	21.1	0.000
IADL	15.2	22.5	0.000	11.4	17.7	0.000
NAGI	59.2	69.9	0.000	52.2	65.6	0.000
Severe ADL	6.2	8.9	0.000	4.5	8.9	0.000
Severe IADL	4.0	6.6	0.000	3.1	5.6	0.000
Severe NAGI	20.5	29.8	0.000	21.3	31.0	0.000
BMI (mean) *	26.6	27.7	0.000	26.8	27.9	0.003
Obesity	23.8	28.4	0.000	22.0	28.5	0.053
Cancer	3.9	3.8	0.855	1.9	2.3	0.311
Heart disease	19.8	26.4	0.000	3.9	7.8	0.000
Stroke	6.2	9.3	0.000	3.5	5.3	0.003
Arthritis	42.0	45.0	0.017	24.7	27.2	0.074

Note: * BMI in SABE does not include Argentina. Only 20% of the MHAS sample has anthropometric measures.

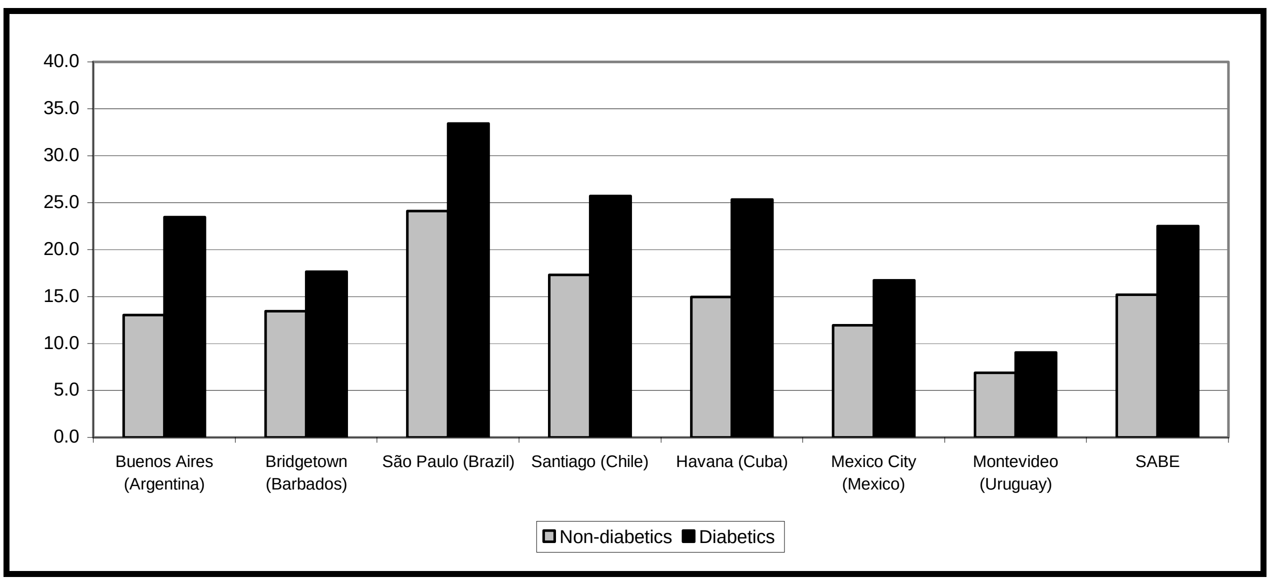
Table 3: Prevalence of ADL, IADL and NAGI limitations among elderly people (60+) in Latin America and the Caribbean by diabetic status, SABE

	ADL		IADL		NAGI	
City/country	Non-diabetics	Diabetics	Non-diabetics	Diabetics	Non-diabetics	Diabetics
SABE	**19.0**	**25.3**	**15.2**	**22.5**	**59.2**	**69.9**
Buenos Aires (Argentina)	17.5	26.5	13.0	23.5	58.2	69.5
Bridgetown (Barbados)	13.6	17.3	13.4	17.7	49.1	59.6
São Paulo (Brazil)	22.9	27.4	24.1	33.4	63.5	72.6
Santiago (Chile)	24.1	34.9	17.3	25.7	66.5	73.7
Havana (Cuba)	18.7	30.4	15.0	25.3	60.6	74.5
Mexico City (Mexico)	18.5	22.2	11.9	16.7	63.3	73.7
Montevideo (Uruguay)	16.1	21.3	6.9	9.0	52.0	65.8

Graph 1: Prevalence of ADL among elderly people (60+) in Latin America and the Caribbean by diabetic status, SABE



Graph 2: Prevalence of IADL among elderly people (60+) in Latin America and the Caribbean by diabetic status, SABE



Graph 3: Prevalence of NAGI among elderly people (60+) in Latin America and the Caribbean by diabetic status, SABE

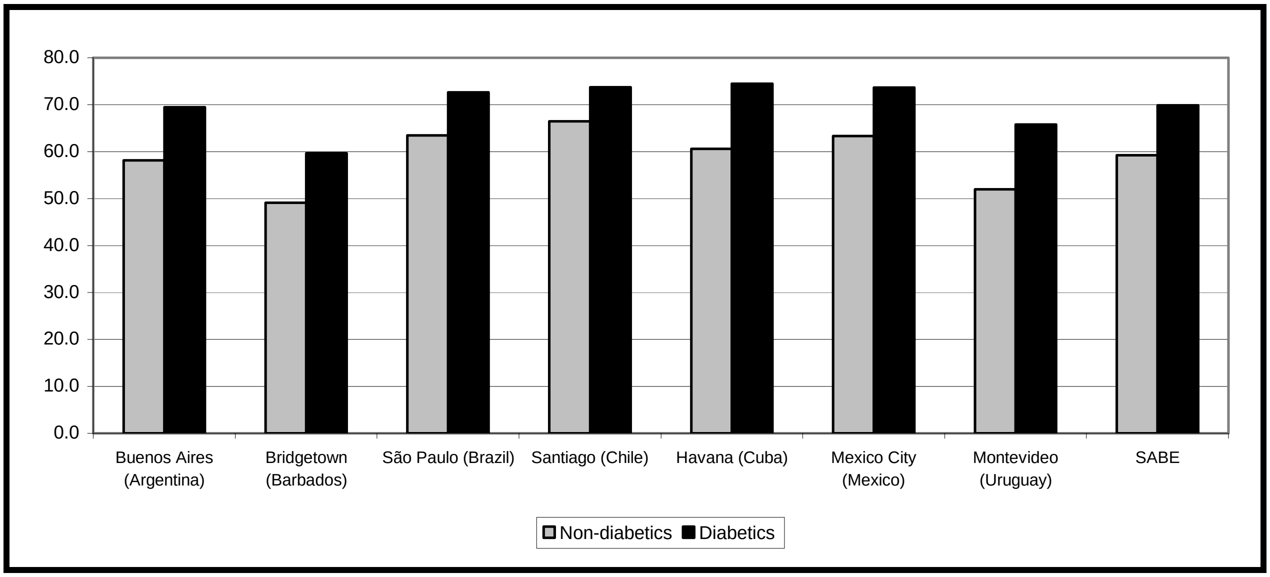


Table 4: Crude and standardized prevalence rates of ADL, IADL and NAGI limitations among elderly people (60+) in Latin America and the Caribbean, SABE

	ADL		IADL		NAGI	
Cities	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Buenos Aires (Argentina)	18.6	17.8	14.4	13.8	59.6	57.9
Bridgetown (Barbados)	14.4	12.1	14.4	11.7	51.4	48.7
São Paulo (Brazil)	23.7	20.1	25.8	20.3	65.1	60.6
Santiago (Chile)	25.5	23.6	18.4	16.5	67.4	65.6
Havana (Cuba)	20.5	18.0	16.5	12.9	62.7	60.4
Mexico City (Mexico)	19.3	19.2	13.0	12.8	65.6	65.5
Montevideo (Uruguay)	16.7	16.4	7.1	7.0	53.8	53.0

Note: WHO population is the standard.

Table 5 shows that for all selected activities those with diabetes have more difficulty performing those activities than individuals never diagnosed with the disease. Elderly individuals face, in general, mobility limitations, such as walking several blocks or climbing stairs, but diabetics suffer even more. Near 70% of elderly individuals with diabetes have difficulty climbing several steps, while almost half are have difficulty walking several blocks. Muscular and skeletal changes also make more difficult for elderly individuals to lift and move objects. In both SABE and MHAS samples, over 1/4 of the elderly population has difficulties performing those activities, but over 1/3 of the diabetics struggle with those difficulties. Difficulty to shop for groceries also imposes limitations on the daily lives of aged individuals and even more among diabetics. A higher percentage of diabetics needs help to get dressed, bathing and using the toilet than non-diabetics.

Table 5: **Difficulty performing selected activities by diabetic status, SABE and MHAS-first wave**

	Non-diabetics	Diabetics	p-value
SABE			
Pushing	26.5	33.9	0.0000
Lifting	33.1	41.3	0.0000
Walking several blocks	38.0	48.7	0.0000
Climbing several steps	63.1	71.6	0.0000
Dressing	11.3	14.4	0.0002
Bathing	7.9	11.5	0.0000
Toileting	4.5	7.4	0.0000
Shopping	9.8	15.0	0.0000
Medication	7.3	11.7	0.0000
MHAS			
Pushing	28.4	37.6	0.0000
Lifting	26.0	37.9	0.0000
Walking several blocks	31.6	45.5	0.0000
Climbing several steps	57.1	69.2	0.0000
Dressing	8.6	12.8	0.0000
Bathing	9.2	13.7	0.0001
Toileting	8.7	13.5	0.0000
Shopping	12.8	18.1	0.0000
Medication	4.0	5.4	0.0081

Diabetes is associated with higher odds of having ADL, IADL and NAGI limitations

Individuals with diabetes face increased risks of having difficulties performing at least one basic activity of the daily living (Table 6 and Table 7). The odds of having ADL limitations are 38% higher among diabetics than non-diabetics in São Paulo, but the risk is more than doubled in Mexico (Model 1). If other medical conditions are taken into account, the risk of having diabetes remains higher among diabetics – ranging from 1.6 times higher in Havana to 1.93 in Mexico. This higher risk of having ADL among diabetics remains even after obesity is taken into account (Model 4a). In Havana, those with diabetes are 50% more likely to have ADL than non-diabetics, and this risk is almost doubled in Mexico.

Limitations on instrumental activities of the daily living are also more likely to affect the lives of diabetics than non-diabetics. In fact, those with diabetes are 50-100% more likely to have IADL than non-diabetics (Model 1) even if chronic conditions are taken into account. Among diabetics, the odds of IADL are 50%, 65%, 67%, 77% and 83% higher in Bridgetown, Mexico City, São Paulo, Santiago and Havana, respectively. The odds of having IADL are twice as higher in Buenos Aires and Mexico among diabetics versus non-diabetics. Even after including obesity in the model, the diabetes coefficient remains significant in Havana, Santiago, São Paulo and Mexico.

Diabetes is also associated with increased risks of having functional limitations. Model 1 shows increased odds of having NAGI limitations that range from 1.5 in Bridgetown to 2.21 in Mexico. If other medical conditions are taken into account (Model 3), then odds are reduced, but remain statistically significant in Bridgetown, São Paulo, Mexico City, Montevideo and Mexico. The Model 4 shows that even after taking obesity into consideration, the odds of having NAGI are increased for those with diabetes. In São Paulo and Montevideo, diabetics are about 1.5 times more likely to have at least one NAGI limitation than non-diabetics. In Mexico and Mexico City, these values are even higher – diabetics are 2 and 1.7 times more likely to have difficulty performing at least one NAGI activity than non-diabetics.

Table 6: Test of hypothesis 1: odds of having at least one ADL, IADL and NAGI limitation are significantly higher among elderly individuals with diabetes (Models 1 and 3) – SABE and MHAS

Cities/Country	Model 1		Model 3		Sample size
ADL					
Buenos Aires	1.83**	[1.16 - 2.87]	1.59	[1.00 - 2.55]	1,019
Bridgetown	1.44*	[1.01 - 2.04]	1.23	[0.85 - 1.80]	1,449
São Paulo	1.38*	[1.06 - 1.80]	1.16	[0.88 - 1.54]	2,060
Santiago	1.85**	[1.29 - 2.64]	1.80**	[1.23 - 2.63]	1,249
Havana	1.76**	[1.31 - 2.36]	1.64**	[1.21 - 2.23]	1,890
Mexico City	1.31	[0.93 - 1.84]	1.34	[0.93 - 1.92]	1,206
Montevideo	1.45	[0.98 - 2.14]	1.21	[0.80 - 1.82]	1,421
Mexico	2.12**	[1.79 - 2.52]	1.93**	[1.68 - 2.22]	11,652
IADL					
Buenos Aires	2.32**	[1.42 - 3.80]	2.02**	[1.21 - 3.37]	1,028
Bridgetown	1.54*	[1.08 - 2.20]	1.49*	[1.03 - 2.15]	1,441
São Paulo	1.87**	[1.44 - 2.44]	1.67**	[1.26 - 2.21]	2,063
Santiago	1.80**	[1.21 - 2.70]	1.77**	[1.17 - 2.69]	1,260
Havana	1.92**	[1.37 - 2.71]	1.83**	[1.28 - 2.61]	1,890
Mexico City	1.66*	[1.11 - 2.48]	1.65*	[1.09 - 2.49]	1,212
Montevideo	1.47	[0.84 - 2.57]	1.19	[0.66 - 2.14]	1,424
Mexico	2.26**	[1.90 - 2.69]	1.97**	[1.65 - 2.36]	11,701
NAGI					
Buenos Aires	1.84**	[1.21 - 2.80]	1.51	[0.97 - 2.37]	1,019
Bridgetown	1.54**	[1.18 - 2.01]	1.39*	[1.04 - 1.84]	1,461
São Paulo	1.66**	[1.28 - 2.15]	1.39*	[1.05 - 1.84]	2,062
Santiago	1.46*	[1.00 - 2.13]	1.35	[0.91 - 2.01]	1,260
Havana	1.48*	[1.10 - 1.99]	1.25	[0.91 - 1.71]	1,892
Mexico City	1.69**	[1.23 - 2.32]	1.79**	[1.29 - 2.49]	1,215
Montevideo	1.83**	[1.31 - 2.55]	1.58*	[1.11 - 2.26]	1,417
Mexico	2.21**	[1.91 - 2.55]	1.93**	[1.68 - 2.22]	11,719

Note: ** p<0.01 and * p<0.05

Table 7: Test of hypothesis 1: odds of having at least one ADL, IADL and NAGI limitation are significantly higher among elderly individuals with diabetes (Models 2 and 4a) – SABE and MHAS

Cities/Country	Model 2		Model 4a		Sample size
ADL					
Buenos Aires (a)	–	–	–	–	–
Bridgetown	1.14	[0.76 - 1.71]	0.94	[0.61 - 1.46]	1,373
São Paulo	1.24	[0.92 - 1.68]	1.10	[0.80 - 1.51]	1,731
Santiago	1.80**	[1.24 - 2.61]	1.80**	[1.21 - 2.66]	1,169
Havana	1.63**	[1.16 - 2.27]	1.51*	[1.06 - 2.14]	1,662
Mexico City	1.15	[0.77 - 1.70]	1.20	[0.80 - 1.81]	1,008
Montevideo	1.29	[0.84 - 1.96]	1.07	[0.68 - 1.66]	1,296
Mexico (b)	1.68**	[1.14 - 2.49]	1.99**	[1.43 - 2.76]	2,069
IADL					
Buenos Aires (a)	–	–	–	–	–
Bridgetown	1.37	[0.92 - 2.03]	1.36	[0.90 - 2.06]	1,361
São Paulo	1.77**	[1.32 - 2.39]	1.64**	[1.20 - 2.24]	1,731
Santiago	1.74*	[1.14 - 2.65]	1.76*	[1.14 - 2.72]	1,179
Havana	1.65*	[1.12 - 2.43]	1.52*	[1.02 - 2.27]	1,662
Mexico City	1.28	[0.79 - 2.07]	1.30	[0.79 - 2.12]	1,011
Montevideo	1.47	[0.81 - 2.66]	1.20	[0.64 - 2.24]	1,301
Mexico (b)	2.56**	[1.73 - 3.78]	2.27**	[1.53 - 3.39]	2,078
NAGI					
Buenos Aires (a)	–	–	–	–	–
Bridgetown	1.38*	[1.05 - 1.81]	1.24	[0.92 - 1.66]	1,381
São Paulo	1.68**	[1.26 - 2.25]	1.50**	[1.10 - 2.04]	1,730
Santiago	1.42	[0.97 - 2.09]	1.35	[0.90 - 2.02]	1,179
Havana	1.33	[0.97 - 1.81]	1.12	[0.81 - 1.56]	1,664
Mexico City	1.62**	[1.15 - 2.28]	1.73**	[1.21 - 2.46]	1,015
Montevideo	1.78**	[1.26 - 2.51]	1.53*	[1.06 - 2.22]	1,293
Mexico (b)	2.13**	[1.52 - 2.99]	1.99**	[1.43 - 2.76]	2,081

Note: (a) Argentina did not collect anthropometric measures and (b) refers to 20% of the sample that has anthropometric information. ** p<0.01 and * p<0.05

Table 8 shows that, in both SABE and MHAS samples, diabetes significantly increases the risks of having functional limitations. The odds of having difficulty bathing independently are 2.4 higher among Mexican diabetics than among non-diabetics (Model 3). In the SABE sample, the odds of having difficulties bathing themselves are 1.5 times higher among diabetics (Model 3). Another aspect that brings higher dependency of diabetics can be shown on their higher chances of having problems using the toilet. Diabetics in Mexico and in the SABE sample are 2.2 and 1.7 times, respectively, more likely to have difficulties using the toilet than non-diabetics. Mobility limitations are also more likely to be present on lives of diabetics. As a matter fact, diabetics are 1.5 to 2.1 times more likely to have difficulties walking several blocks than non-diabetics. Diabetics are also more likely to have difficulties climbing several steps, taking medication, lifting weight, shopping, and dressing than non-diabetics.

Table 8: Test of hypothesis 1: odds of having at least one functional limitation are significantly higher among elderly individuals with diabetes – SABE and MHAS

	Model 1		Model 3		Sample size
SABE					
Pushing	1.48**	[1.32 - 1.67]	1.35**	[1.19 - 1.52]	10,330
Lifting	1.48**	[1.32 - 1.66]	1.31**	[1.16 - 1.47]	10,327
Walking several blocks	1.66**	[1.48 - 1.87]	1.51**	[1.34 - 1.70]	9,128
Climbing several steps	1.51**	[1.32 - 1.72]	1.36**	[1.19 - 1.56]	9,111
Dressing	1.36**	[1.16 - 1.59]	1.20*	[1.02 - 1.42]	9,103
Bathing	1.65**	[1.38 - 1.99]	1.48**	[1.22 - 1.79]	9,086
Toileting	1.79**	[1.44 - 2.22]	1.62**	[1.30 - 2.04]	9,070
Shopping	1.68**	[1.42 - 1.97]	1.52**	[1.28 - 1.80]	9,055
Medication	1.80**	[1.50 - 2.16]	1.62**	[1.34 - 1.96]	9,037
MHAS					
Pushing	1.90**	[1.64 - 2.19]	1.68**	[1.46 - 1.94]	11,702
Lifting	2.26**	[1.95 - 2.61]	2.00**	[1.74 - 2.30]	11,701
Walking several blocks	2.45**	[2.09 - 2.88]	2.11**	[1.81 - 2.47]	11,709
Climbing several steps	2.01**	[1.75 - 2.30]	1.79**	[1.56 - 2.04]	11,599
Dressing	1.88**	[1.58 - 2.23]	1.66**	[1.39 - 1.99]	11,687
Bathing	2.67**	[2.18 - 3.28]	2.40**	[1.94 - 2.97]	12,711
Toileting	2.43**	[2.01 - 2.95]	2.17**	[1.78 - 2.65]	12,704
Shopping	2.37**	[1.98 - 2.85]	2.10**	[1.74 - 2.53]	11,712
Medication	1.96**	[1.55 - 2.47]	1.72**	[1.35 - 2.18]	11,705

Note: ** p<0.01 and * p<0.05

Diabetes also increases the chances of having difficulties performing at least 3 basic and instrumental activities of daily living (Table 9 and Table 10). In Buenos Aires, São Paulo, Havana and Mexico the risks of having difficulties performing at least 3 ADLs is 60-120% higher among diabetics (Model 3). However, obesity mediates a good amount of this additional burden as shown in Model 4a. In fact, diabetes coefficients remain in the right direction, but they become non-significant in most places. The risks of having severe IADL limitations among diabetics are 2.5, 2.6 and 2.9 times higher than among non-diabetics in Santiago, Bridgetown and Mexico, respectively (Model 4a).

The odds of having difficulties performing at least 3 NAGI activities are also higher among diabetics. In Model 3, in all settings diabetics face risks of having severe NAGI limitations 1.4 to 2 times higher than non-diabetics. After considering the mediating effect of obesity, the diabetes coefficient becomes non-significant in Bridgetown and São Paulo. However, in Havana, Santiago, Mexico City, Montevideo and Mexico, diabetics face risks about 1.5 to 2 times higher than non-diabetics even after obesity is included in the model (Table 10).

Table 9: Test of hypothesis 1: odds of having at least three ADL, IADL and NAGI limitations are significantly higher among elderly individuals with diabetes (Models 1 and 3) – SABE and MHAS

Cities/Country	Model 1		Model 3		Sample size
Severe ADL					
Buenos Aires	2.13*	[1.08 - 4.23]	2.12*	[1.04 - 4.35]	1,019
Bridgetown	1.54	[0.87 - 2.76]	1.33	[0.72 - 2.45]	1,449
São Paulo	1.93**	[1.32 - 2.83]	1.60*	[1.05 - 2.43]	2,060
Santiago	1.26	[0.73 - 2.17]	1.15	[0.64 - 2.05]	1,249
Havana	1.73*	[1.11 - 2.69]	1.68*	[1.06 - 2.69]	1,890
Mexico City	1.22	[0.73 - 2.07]	1.37	[0.80 - 2.35]	1,206
Montevideo	1.52	[0.72 - 3.21]	1.32	[0.60 - 2.91]	1,421
Mexico	2.48**	[2.01 - 3.07]	2.19**	[1.76 - 2.72]	11,652
Severe IADL					
Buenos Aires	4.67**	[2.08 - 10.45]	4.98**	[2.05 - 12.10]	1,028
Bridgetown	2.79**	[1.42 - 5.48]	2.58*	[1.24 - 5.36]	1,441
São Paulo	1.62*	[1.09 - 2.42]	1.49	[0.97 - 2.30]	2,063
Santiago	2.54**	[1.32 - 4.92]	2.51**	[1.25 - 5.03]	1,260
Havana	1.35	[0.79 - 2.29]	1.27	[0.73 - 2.21]	1,890
Mexico City	1.81	[0.91 - 3.62]	1.73	[0.85 - 3.51]	1,212
Montevideo (a)	–	–	–	–	–
Mexico	2.80**	[2.20 - 3.58]	2.19**	[1.76 - 2.72]	11,701
Severe NAGI					
Buenos Aires	1.85**	[1.21 - 2.82]	1.67*	[1.07 - 2.59]	1,019
Bridgetown	1.95**	[1.39 - 2.74]	1.70**	[1.19 - 2.44]	1,461
São Paulo	1.65**	[1.28 - 2.12]	1.40*	[1.06 - 1.85]	2,062
Santiago	1.55*	[1.08 - 2.22]	1.50*	[1.03 - 2.18]	1,260
Havana	1.73**	[1.28 - 2.34]	1.55**	[1.12 - 2.13]	1,892
Mexico City	1.58**	[1.16 - 2.16]	1.64**	[1.19 - 2.27]	1,215
Montevideo	2.29**	[1.57 - 3.32]	1.98**	[1.33 - 2.96]	1,417
Mexico	2.24**	[1.93 - 2.62]	1.98**	[1.70 - 2.30]	11,719

Note: (a) Variable diabetes predicts failure perfectly and it was dropped. ** $p<0.01$ and * $p<0.05$

Table 10: Test of hypothesis 1: odds of having at least three ADL, IADL and NAGI limitations are significantly higher among elderly individuals with diabetes (Models 2 and 4a) – SABE and MHAS

	Model 2		Model 4a		Sample size
ADL					
Buenos Aires (a)	–	–	–	–	–
Bridgetown	1.15	[0.48 - 2.73]	1.00	[0.40 - 2.49]	1,373
São Paulo	1.75*	[1.04 - 2.94]	1.49	[0.86 - 2.57]	1,731
Santiago	1.18	[0.64 - 2.16]	1.13	[0.60 - 2.13]	1,169
Havana	1.45	[0.81 - 2.60]	1.31	[0.71 - 2.39]	1,662
Mexico City	0.92	[0.46 - 1.82]	1.09	[0.54 - 2.21]	1,008
Montevideo	1.63	[0.70 - 3.79]	1.34	[0.55 - 3.25]	1,296
Mexico	3.00**	[1.77 - 5.06]	2.85**	[1.66 - 4.90]	2,069
IADL					
Buenos Aires (a)	–	–	–	–	–
Bridgetown	2.82*	[1.18 - 6.73]	2.63*	[1.03 - 6.70]	1,361
São Paulo	1.34	[0.79 - 2.27]	1.18	[0.68 - 2.04]	1,731
Santiago	2.43*	[1.17 - 5.06]	2.49*	[1.17 - 5.28]	1,179
Havana	1.01	[0.48 - 2.13]	0.94	[0.44 - 2.03]	1,662
Mexico City	1.49	[0.60 - 3.70]	1.46	[0.57 - 3.75]	1,011
Montevideo	–	–	–	–	–
Mexico	3.27**	[1.70 - 6.30]	2.85**	[1.66 - 4.90]	2,078
NAGI					
Buenos Aires (a)	–	–	–	–	–
Bridgetown	1.69**	[1.15 - 2.49]	1.45	[0.96 - 2.20]	1,381
São Paulo	1.42*	[1.06 - 1.89]	1.24	[0.91 - 1.69]	1,730
Santiago	1.52*	[1.04 - 2.21]	1.49*	[1.01 - 2.19]	1,179
Havana	1.65**	[1.18 - 2.31]	1.46*	[1.02 - 2.08]	1,664
Mexico City	1.46*	[1.04 - 2.06]	1.55*	[1.09 - 2.21]	1,015
Montevideo	2.34**	[1.58 - 3.47]	2.02**	[1.32 - 3.08]	1,293
Mexico	2.00**	[1.38 - 2.89]	1.80**	[1.25 - 2.58]	2,081

Note: (a) Argentina did not collect anthropometric measures.** p<0.01 and * p<0.05

Diabetes also increases the odds of having increasing numbers of limitations on activities of daily living. Table 11 shows that having diabetes increases the likelihood of being in a higher ADL category. In Santiago, Havana and Mexico individuals with diabetes are about 1.5 times more likely to be observed with a higher number of ADL limitations than non-diabetics (Model 4a). Reporting having diabetes is also associated with a higher likelihood of having a larger number of IADL limitations. In Buenos Aires, São Paulo, Santiago, Havana and Mexico, the odds of being in a higher category of IADL limitations is 50-120% higher for diabetics. Finally, having diabetes increases about 30-70% the chances of being observed with a higher number of NAGI limitations in all settings, except Bridgetown, Santiago and Havana.

Table 11: Test of hypothesis 1: odds of having increasing numbers of ADL, IADL and NAGI limitations are significantly higher among elderly individuals with diabetes (Models 1 and 4a) – SABE and MHAS

City/Country	Model 1		Model 4a	
ADL				
Buenos Aires	1.85**	[1.19 - 2.88]	1.57	[0.99 - 2.49]
Bridgetown	1.16	[0.77 - 1.74]	0.95	[0.62 - 1.46]
São Paulo	1.32	[0.98 - 1.78]	1.15	[0.84 - 1.56]
Santiago	1.66**	[1.16 - 2.37]	1.63**	[1.13 - 2.37]
Havana	1.58**	[1.14 - 2.19]	1.47*	[1.05 - 2.07]
Mexico City	1.12	[0.76 - 1.66]	1.20	[0.80 - 1.79]
Montevideo	1.26	[0.83 - 1.92]	1.06	[0.69 - 1.64]
Mexico	1.90**	[1.66 - 2.18]	1.50**	[1.05 - 2.15]
IADL				
Buenos Aires	2.47**	[1.53 - 3.99]	2.17**	[1.32 - 3.58]
Bridgetown	1.39	[0.94 - 2.06]	1.39	[0.92 - 2.09]
São Paulo	1.70**	[1.28 - 2.25]	1.49**	[1.11 - 2.00]
Santiago	1.77**	[1.17 - 2.67]	1.77**	[1.16 - 2.70]
Havana	1.65**	[1.13 - 2.40]	1.50*	[1.02 - 2.21]
Mexico City	1.29	[0.80 - 2.08]	1.32	[0.81 - 2.15]
Montevideo	1.45	[0.81 - 2.63]	1.13	[0.60 - 2.12]
Mexico	1.99**	[1.72 - 2.31]	2.09*	[1.45 - 3.01]
NAGI				
Buenos Aires	1.66**	[1.19 - 2.33]	1.46*	[1.03 - 2.07]
Bridgetown	1.53**	[1.20 - 1.95]	1.28	[0.99 - 1.65]
São Paulo	1.48**	[1.19 - 1.84]	1.28*	[1.02 - 1.61]
Santiago	1.39*	[1.04 - 1.87]	1.32	[0.98 - 1.78]
Havana	1.45**	[1.13 - 1.86]	1.25	[0.96 - 1.61]
Mexico City	1.41*	[1.08 - 1.83]	1.50**	[1.15 - 1.96]
Montevideo	1.83**	[1.36 - 2.46]	1.56**	[1.15 - 2.11]
Mexico	1.83**	[1.66 - 2.01]	1.68**	[1.34 - 2.12]

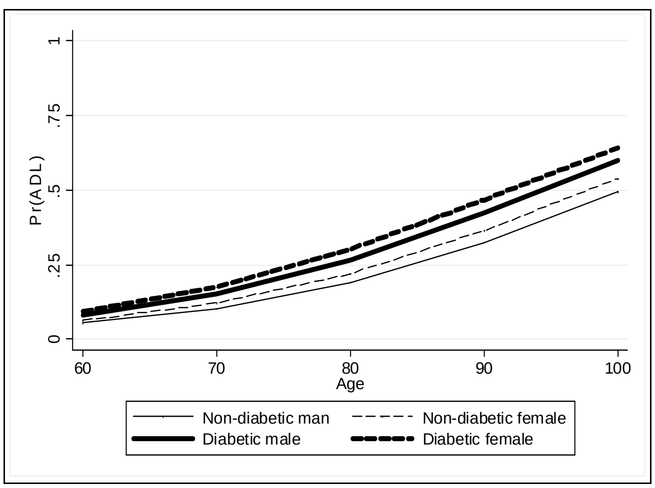
Note: ** $p<0.01$ and * $p<0.05$

The prevalence of limitations on basic and instrumental activities of daily living and on functional activities measured by the NAGI scale increase significantly with age (Graph 4 to Graph 6.). For ADL and IADL limitations, increases in the prevalence of ADL and IADL follow a very steep curve, while the prevalence of NAGI limitations suffers from a ceiling effect, as almost every elderly develops them.

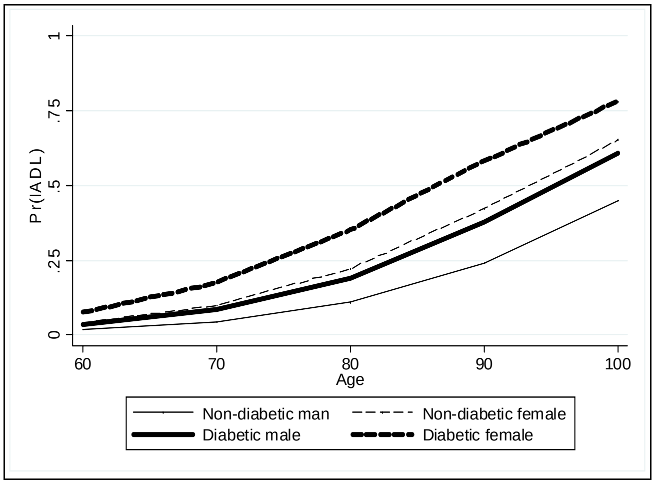
Women are more likely than men to report having difficulties performing basic and instrumental activities of daily living. Women are also more likely to have problems with NAGI activities (Graph 4 to Graph 6).

Diabetics are at increased risk of having difficulties performing ADL, IADL and NAGI activities. The effect of diabetes can be particularly noticed in the difference in the prevalence of IADL as age increases, and probably the duration of the condition. For NAGI limitations, the differences between diabetics and non-diabetics are larger at younger ages, as NAGI disability becomes more prevalent with aging.

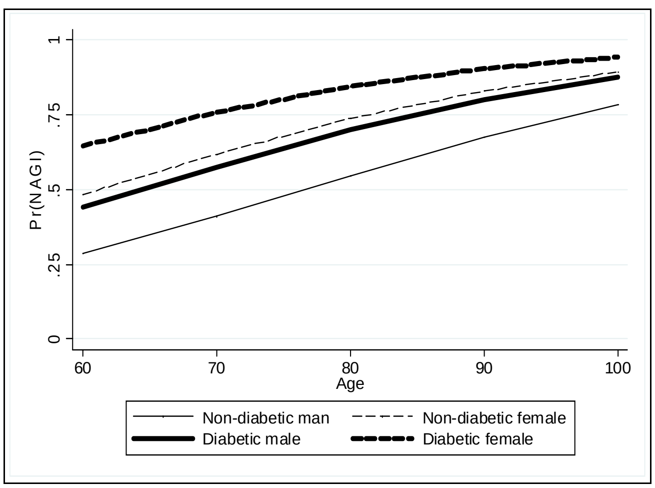
Graph 4: Predicted probabilities of having difficulty performing at least one ADL activity by age and sex based on Model 4, MHAS



Graph 5: Predicted probabilities of having difficulty performing at least one IADL activity by age and sex based on Model 4, MHAS



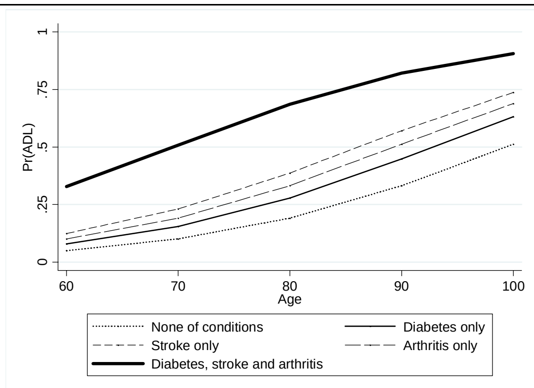
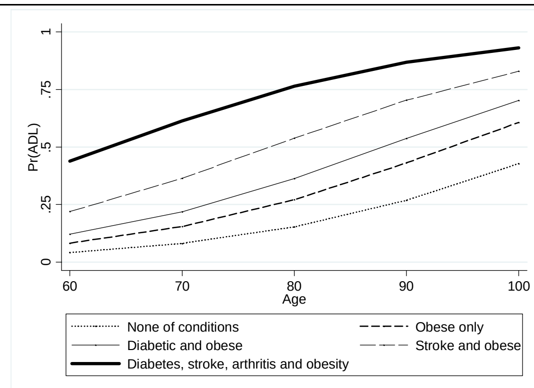
Graph 6: Predicted probabilities of having difficulty performing at least one NAGI activity by age and sex based on Model 4, MHAS



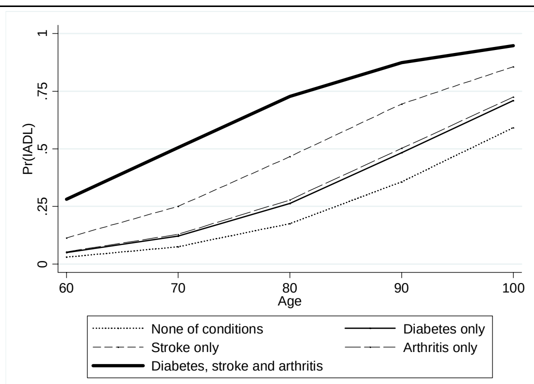
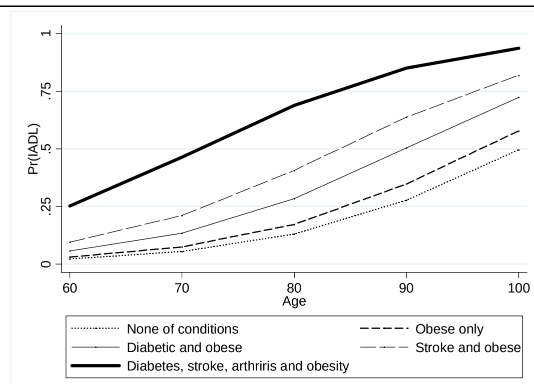
Results (not shown) indicate that not only diabetes increases the risks of having mobility and functional limitations, but having had a stroke has consequences on the individuals' ability to perform daily activities. Arthritis is another important disabling condition.

Graph 7 shows that the effects of diabetes on the likelihood of having ADL is not as dramatic as having had a stroke or having arthritis, but the combined effects of these three conditions severely reduces the wellbeing of individuals. Being diabetic and obese also imposes additional burden on individuals. The same is true for the predicted probabilities of having difficulties performing at least one IADL (Graph 8). Finally, Graph 9 shows that individuals who are diabetic and obese are more likely to have difficulty performing at least one NAGI activity than obese individuals who had a stroke, but that are not diabetic.

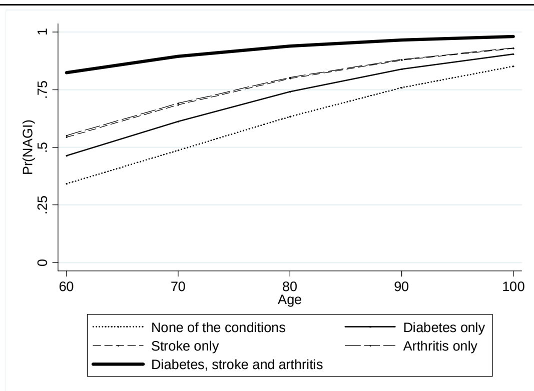
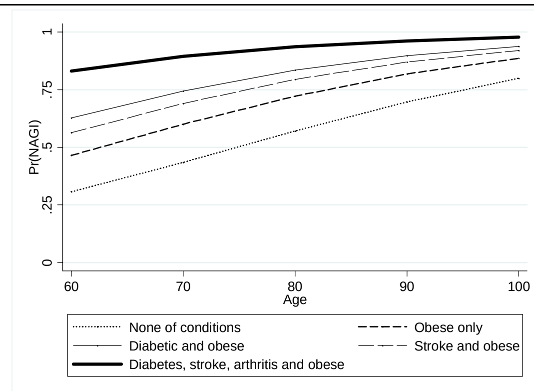
Graph 7: Prevalence of ADL by age given selected chronic conditions, MHAS

Model 3	Model 4
	

Graph 8: Prevalence of IADL by age given selected chronic conditions, MHAS

Model 3	Model 4
	

Graph 9: Prevalence of NAGI by age given selected chronic conditions, MHAS

Model 3	Model 4
	

Estimates of the odds of developing ADL, IADL and NAGI limitations

Diabetes is associated with the onset of functional disability in Mexico. Data from MHAS indicates that the risk of developing ADL is more than 70% higher among diabetics than non-diabetics (Table 12). The effect of having diabetes on the incidence of ADL remains positive even after considering the disabling effects of obesity. However, the coefficients are no longer significant as the sample size is significantly reduced. The consequence of having diabetes on the incidence of IADL is shown on Table 12. Individuals with diabetes at baseline are about 2-3 times more likely to develop IADL in a two-year period than non-diabetics. The risk of becoming physically limited (NAGI) is increased by more than 50% for those with diabetes, but the coefficient is not significant in Model 4.

Table 12: Test of hypothesis 2: individuals with diabetes at baseline are more likely to develop ADL, IADL and NAGI limitations, MHAS

Variables	Model 1		Model 2		Model 3		Model 4	
ADL								
Age	1.05**	[1.04 - 1.06]	1.05**	[1.01 - 1.08]	1.05**	[1.03 - 1.06]	1.05**	[1.01 - 1.08]
Female	1.50**	[1.23 - 1.84]	2.08**	[1.25 - 3.44]	1.37**	[1.09 - 1.72]	1.87*	[1.06 - 3.31]
Diabetes	1.85**	[1.46 - 2.33]	1.55	[0.87 - 2.76]	1.75**	[1.38 - 2.21]	1.48	[0.81 - 2.70]
Obese			1.04	[0.58 - 1.85]			0.94	[0.51 - 1.70]
HBP					1.25*	[1.02 - 1.53]	1.35	[0.82 - 2.23]
Heart					1.00	[0.61 - 1.63]	0.71	[0.20 - 2.53]
Stroke					2.20**	[1.37 - 3.54]	2.42	[0.75 - 7.87]
Cancer					0.97	[0.46 - 2.05]	0.98	[0.22 - 4.45]
Lung disease					1.37	[0.96 - 1.97]	1.63	[0.69 - 3.89]
Arthritis					1.64**	[1.32 - 2.03]	1.93*	[1.16 - 3.20]
Never smoked					1.02	[0.82 - 1.28]	1.00	[0.58 - 1.71]
Observations	5082		911		5082		911	
IADL								
Age	1.08**	[1.07 - 1.10]	1.10**	[1.07 - 1.14]	1.08**	[1.07 - 1.10]	1.10**	[1.07 - 1.14]
Female	2.02**	[1.62 - 2.51]	1.92*	[1.15 - 3.21]	1.92**	[1.50 - 2.46]	2.34**	[1.30 - 4.21]
Diabetes	1.93**	[1.51 - 2.46]	2.81**	[1.61 - 4.90]	1.86**	[1.45 - 2.39]	2.90**	[1.63 - 5.16]
Obese			0.87	[0.47 - 1.64]			0.90	[0.47 - 1.72]
HBP					1.09	[0.88 - 1.36]	0.78	[0.46 - 1.33]
Heart					1.58*	[1.00 - 2.49]	2.58	[0.97 - 6.85]
Stroke					1.97*	[1.15 - 3.36]	2.43	[0.72 - 8.26]
Cancer					1.89	[1.00 - 3.59]	2.64	[0.81 - 8.57]
Lung disease					1.09	[0.74 - 1.62]	1.15	[0.45 - 2.93]
Arthritis					1.32*	[1.04 - 1.66]	1.25	[0.72 - 2.17]
Never smoked					1.09	[0.86 - 1.39]	0.71	[0.41 - 1.24]
Observations	5275		955		5275		955	
NAGI								
Age	1.04**	[1.03 - 1.05]	1.05**	[1.02 - 1.08]	1.04**	[1.03 - 1.05]	1.05**	[1.02 - 1.08]
Female	1.75**	[1.48 - 2.06]	2.44**	[1.62 - 3.68]	1.68**	[1.39 - 2.03]	2.43**	[1.51 - 3.93]
Diabetes	1.55**	[1.23 - 1.96]	1.92*	[1.10 - 3.36]	1.47**	[1.16 - 1.86]	1.69	[0.94 - 3.03]
Obese			1.31	[0.77 - 2.21]			1.28	[0.74 - 2.21]
HBP					1.13	[0.94 - 1.35]	1.28	[0.83 - 1.98]
Heart					1.73*	[1.02 - 2.92]	2.77	[0.72 - 10.59]
Stroke					1.42	[0.77 - 2.62]	0.42	[0.07 - 2.36]
Cancer					2.15*	[1.08 - 4.27]	3.32	[0.83 - 13.33]
Lung disease					0.93	[0.63 - 1.38]	0.39	[0.12 - 1.28]
Arthritis					1.66**	[1.33 - 2.07]	2.37**	[1.44 - 3.88]
Never smoked					1.01	[0.84 - 1.22]	0.95	[0.59 - 1.54]
Observations	2753		508		2753		508	

Note: ** $p<0.01$ and * $p<0.05$

Diabetes increases even further the risks of developing severe ADL and IADL (Table 13 and Graph 10). In fact, those with diabetes at the baseline are about 2 times more likely to develop difficulties performing at least 3 activities of the daily living (Models 1 and 3). If obesity is considered, then the odds ratios are no longer significant, but they remain close to 2. As for IADL, all odds ratios are significant and higher than 2. Model 4 indicates that having diabetes at baseline more than triples the risk of developing severe IADL. Having diabetes at baseline increases between 60-130% the chances of developing severe NAGI in a two-year period.

Individuals with diabetes at the baseline are also more likely to develop further difficulties performing ADL, IADL and NAGI conditions (Graph 11). More specifically, diabetics are more than 50% more likely to develop difficulties performing one additional basic or instrumental activity of the daily living than non-diabetics. The same is true for developing further NAGI limitations.

Having diabetes at the baseline more than doubles the risk of developing difficulties bathing. The risk of developing difficulties toileting, shopping and to take medication by themselves is also increased by more than 80% for those with diabetes at the baseline. Diabetics at the baseline are also more likely to become unable to dress without facing difficulties. As for some of the NAGI limitations, effects are also positive. Diabetics are about 60% more likely to develop difficulties lifting heavy objects (e.g. full bag of groceries). On average, having diabetes at baseline increases by about 30% the risk of having difficulties pushing large objects (e.g. living room chair), walking several blocks and climbing several steps (Table 14 and Graph 11, Model 3).

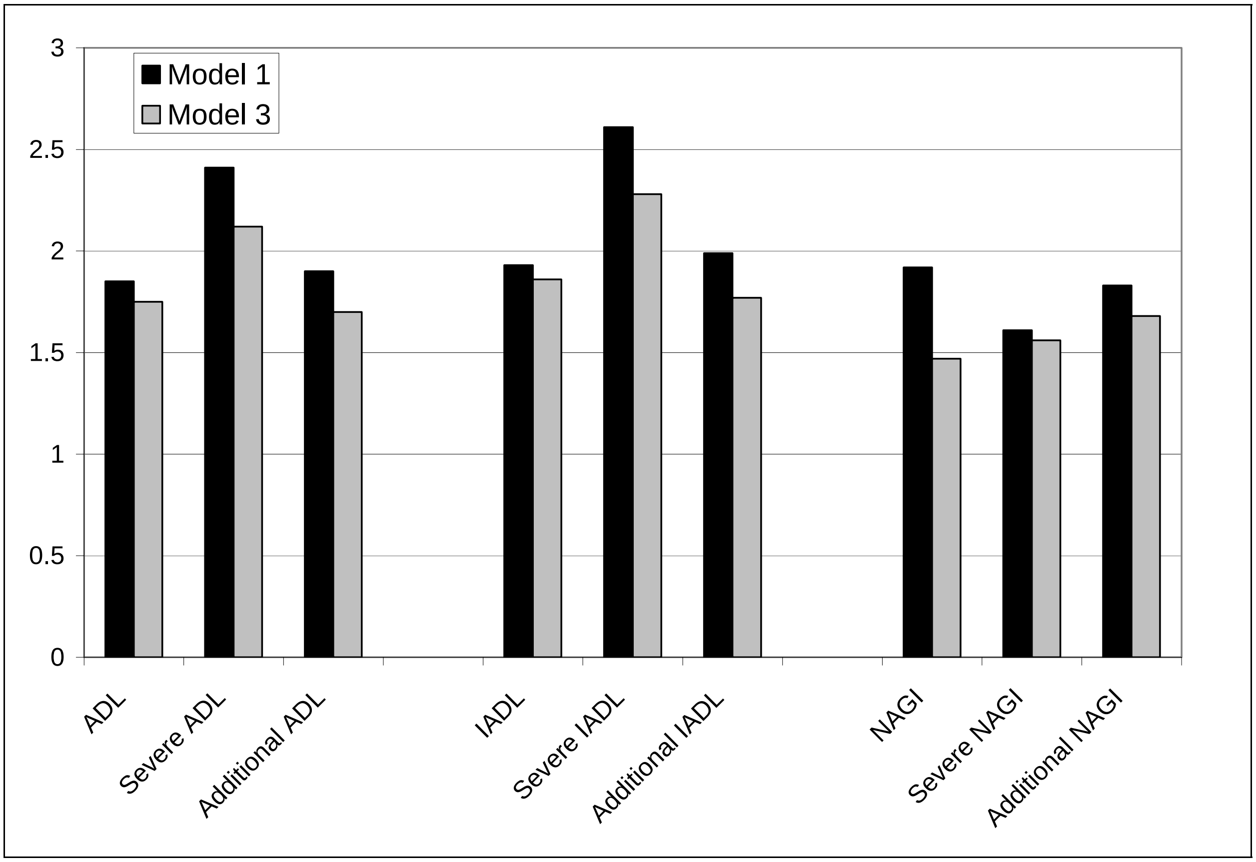
Women in Mexico are more likely than men to develop ADL, IADL or NAGI limitations on a two-year period. They are also more likely to develop severe functional and physical limitations.

Table 13: Test of hypothesis 2: individuals with diabetes at baseline are more likely to develop severe ADL, IADL and NAGI limitations, MHAS

Variables	Model 1		Model 2		Model 3		Model 4	
Severe ADL								
Age	1.09**	[1.07 - 1.11]	1.10**	[1.05 - 1.14]	1.09**	[1.07 - 1.10]	1.10**	[1.05 - 1.14]
Female	1.68**	[1.23 - 2.28]	1.42	[0.70 - 2.90]	1.50*	[1.05 - 2.12]	1.38	[0.61 - 3.13]
Diabetes	2.41**	[1.74 - 3.35]	2.05	[0.92 - 4.57]	2.12**	[1.51 - 2.96]	1.92	[0.84 - 4.38]
Obese			1.66	[0.76 - 3.63]			1.64	[0.73 - 3.68]
HBP					1.78**	[1.30 - 2.43]	1.27	[0.61 - 2.64]
Heart					0.92	[0.47 - 1.77]	0.47	[0.06 - 3.69]
Stroke					2.32**	[1.27 - 4.22]	3.85*	[1.02 - 14.52]
Cancer					0.51	[0.12 - 2.12]		
Lung disease					0.82	[0.46 - 1.48]	0.96	[0.22 - 4.25]
Arthritis					1.89**	[1.39 - 2.56]	1.3	[0.61 - 2.75]
Never smoked					0.91	[0.66 - 1.28]	0.78	[0.36 - 1.71]
Observations	5674		1017		5674		1017	
Severe IADL								
Age	1.10**	[1.08 - 1.13]	1.08**	[1.03 - 1.14]	1.10**	[1.08 - 1.13]	1.08**	[1.02 - 1.14]
Female	1.66**	[1.17 - 2.36]	1.14	[0.47 - 2.75]	1.51*	[1.01 - 2.24]	1.29	[0.46 - 3.64]
Diabetes	2.61**	[1.81 - 3.78]	3.66**	[1.46 - 9.20]	2.28**	[1.57 - 3.33]	3.10*	[1.21 - 7.94]
Obese			0.17	[0.02 - 1.30]			0.13	[0.02 - 1.02]
HBP					1.98**	[1.38 - 2.85]	2.08	[0.79 - 5.46]
Heart					0.88	[0.41 - 1.89]	1.5	[0.30 - 7.40]
Stroke					1.92	[0.93 - 3.94]		
Cancer					1.19	[0.37 - 3.90]		
Lung disease					0.74	[0.37 - 1.49]	0.54	[0.07 - 4.22]
Arthritis					1.14	[0.79 - 1.66]	2.43	[0.99 - 5.98]
Never smoked					0.94	[0.64 - 1.37]	0.67	[0.24 - 1.86]
Observations	5817		1043		5817		1043	
Severe NAGI								
Age	1.07**	[1.06 - 1.08]	1.08**	[1.05 - 1.11]	1.07**	[1.05 - 1.08]	1.08**	[1.05 - 1.12]
Female	2.05**	[1.71 - 2.44]	2.90**	[1.85 - 4.56]	1.86**	[1.52 - 2.27]	2.92**	[1.75 - 4.85]
Diabetes	1.61**	[1.30 - 2.00]	2.25**	[1.37 - 3.68]	1.56**	[1.26 - 1.95]	2.26**	[1.36 - 3.77]
Obese			1.31	[0.80 - 2.14]			1.16	[0.70 - 1.94]
HBP					1.12	[0.94 - 1.35]	1.15	[0.74 - 1.79]
Heart					1.33	[0.85 - 2.08]	0.67	[0.18 - 2.46]
Stroke					1.28	[0.75 - 2.20]	2.06	[0.65 - 6.55]
Cancer					1.77	[0.96 - 3.28]	3.14	[0.97 - 10.14]
Lung disease					1.62**	[1.18 - 2.21]	0.78	[0.29 - 2.10]
Arthritis					1.44**	[1.18 - 1.75]	2.08**	[1.32 - 3.28]
Never smoked					1.14	[0.94 - 1.39]	0.85	[0.53 - 1.37]
Observations	4664		842		4664		842	

Note: ** $p<0.01$ and * $p<0.05$

Graph 10: Test of hypothesis 2: Odds of developing ADL, IADL and NAGI limitations are higher among diabetics, MHAS



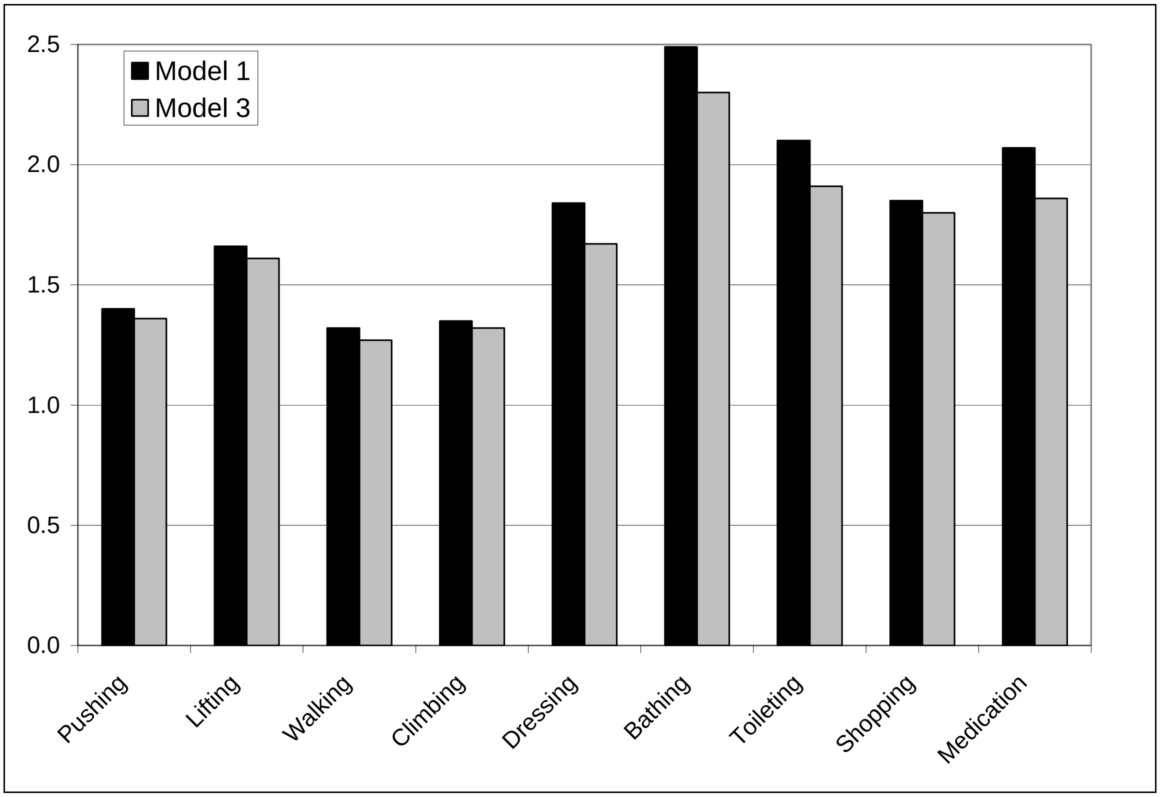
Note: All coefficients are statistically significant (p<0.05).

Table 14: Test of hypothesis 2: Odds of becoming physically and functionally limited is higher among diabetics, selected activities, MHAS

	Model 1		Model 3		Sample size
Pushing	1.40**	[1.14 - 1.73]	1.36**	[1.10 - 1.68]	4219
Lifting	1.66**	[1.35 - 2.04]	1.61**	[1.30 - 1.99]	4336
Walking	1.32*	[1.06 - 1.64]	1.27*	[1.02 - 1.58]	3974
Climbing	1.35*	[1.05 - 1.72]	1.32*	[1.03 - 1.69]	2423
Dressing	1.84**	[1.41 - 2.40]	1.67**	[1.28 - 2.19]	5459
Bathing	2.49**	[1.88 - 3.32]	2.30**	[1.72 - 3.08]	6049
Toileting	2.10**	[1.58 - 2.79]	1.91**	[1.43 - 2.56]	6069
Shopping	1.85**	[1.42 - 2.42]	1.80**	[1.37 - 2.36]	5425
Medication	2.07**	[1.43 - 3.00]	1.86**	[1.27 - 2.70]	5784

Note: ** p<0.01 and * p<0.05

Graph 11: Test of hypothesis 2: the odds of becoming physically and functionally limited is higher among diabetics, selected activities, MHAS



Note: All coefficients are statistically significant (p<0.05).

Estimates of the odds of recovering from ADL, IADL and NAGI limitations

Data from Mexico confirms that individuals with diabetes at the baseline are less likely to recover from disability than individuals without diabetes (Table 15 and Graph 12). Since samples are limited to those with disability at Wave 1, sample sizes are quite smaller. As a result, odds ratios are lower than 1, but they are only significant for the NAGI limitations. Results indicate that diabetics are about 40% less likely to recover from NAGI limitations than non-diabetics (Models 1 and 3). Sample sizes are even smaller if obesity is taken into consideration, and odds ratios are not anymore significant, but they remain under 1.

Diabetics considerably less likely to recover from difficulties performing activities such as pushing a heavy object, lifting about 10 pounds, walking several blocks, climbing several steps or dressing themselves (Table 16 and Graph 12).

Graph 13 to Graph 15 show that the chances of recovering from disability decline significantly with age. Women are also considerably less likely to recover from ADL, IADL or NAGI limitations than men.

Table 15: Test of hypothesis 3: Recovery from disability is lower for those with diabetes at baseline, MHAS

Variables	Model 1		Model 2		Model 3		Model 4	
ADL								
Age	0.95**	[0.93 - 0.97]			0.95**	[0.93 - 0.96]		
Female	0.68*	[0.49 - 0.93]			0.69*	[0.47 - 0.99]		
Diabetes	0.74	[0.52 - 1.05]			0.72	[0.50 - 1.04]		
Obese								
HBP					0.97	[0.70 - 1.34]		
Heart					0.98	[0.54 - 1.75]		
Stroke					0.38**	[0.19 - 0.76]		
Cancer					0.9	[0.32 - 2.52]		
Lung disease					1.21	[0.75 - 1.96]		
Arthritis					0.78	[0.57 - 1.07]		
Never smoked					0.96	[0.67 - 1.36]		
Observations	700				700			
IADL								
Age	0.95**	[0.93 - 0.97]			0.94**	[0.92 - 0.96]		
Female	0.66*	[0.45 - 0.97]			0.63*	[0.40 - 0.97]		
Diabetes	0.67	[0.44 - 1.00]			0.71	[0.47 - 1.09]		
Obese								
HBP					0.84	[0.58 - 1.22]		
Heart					0.76	[0.39 - 1.47]		
Stroke					0.48*	[0.24 - 0.95]		
Cancer					1.31	[0.41 - 4.19]		
Lung disease					1.61	[0.90 - 2.88]		
Arthritis					0.82	[0.57 - 1.16]		
Never smoked					1.09	[0.73 - 1.62]		
Observations	548				548			
NAGI								
Age	0.95**	[0.94 - 0.96]	0.96**	[0.94 - 0.99]	0.95**	[0.94 - 0.96]	0.96*	[0.94 - 0.99]
Female	0.60**	[0.51 - 0.70]	0.88	[0.59 - 1.31]	0.59**	[0.48 - 0.71]	0.80	[0.51 - 1.26]
Diabetes	0.63**	[0.51 - 0.77]	0.70	[0.44 - 1.13]	0.64**	[0.52 - 0.79]	0.70	[0.43 - 1.15]
Obese			0.67	[0.43 - 1.03]			0.73	[0.46 - 1.15]
HBP					0.83*	[0.70 - 0.98]	0.75	[0.50 - 1.11]
Heart					0.51**	[0.33 - 0.78]	0.30*	[0.10 - 0.92]
Stroke					0.48**	[0.30 - 0.78]	0.40	[0.11 - 1.45]
Cancer					1.43	[0.84 - 2.44]	1.71	[0.53 - 5.49]
Lung disease					0.67*	[0.50 - 0.91]	0.61	[0.29 - 1.28]
Arthritis					0.58**	[0.48 - 0.69]	0.64*	[0.42 - 0.98]
Never smoked					1.09	[0.91 - 1.31]	1.10	[0.72 - 1.69]
Observations	2778		486		2778		486	

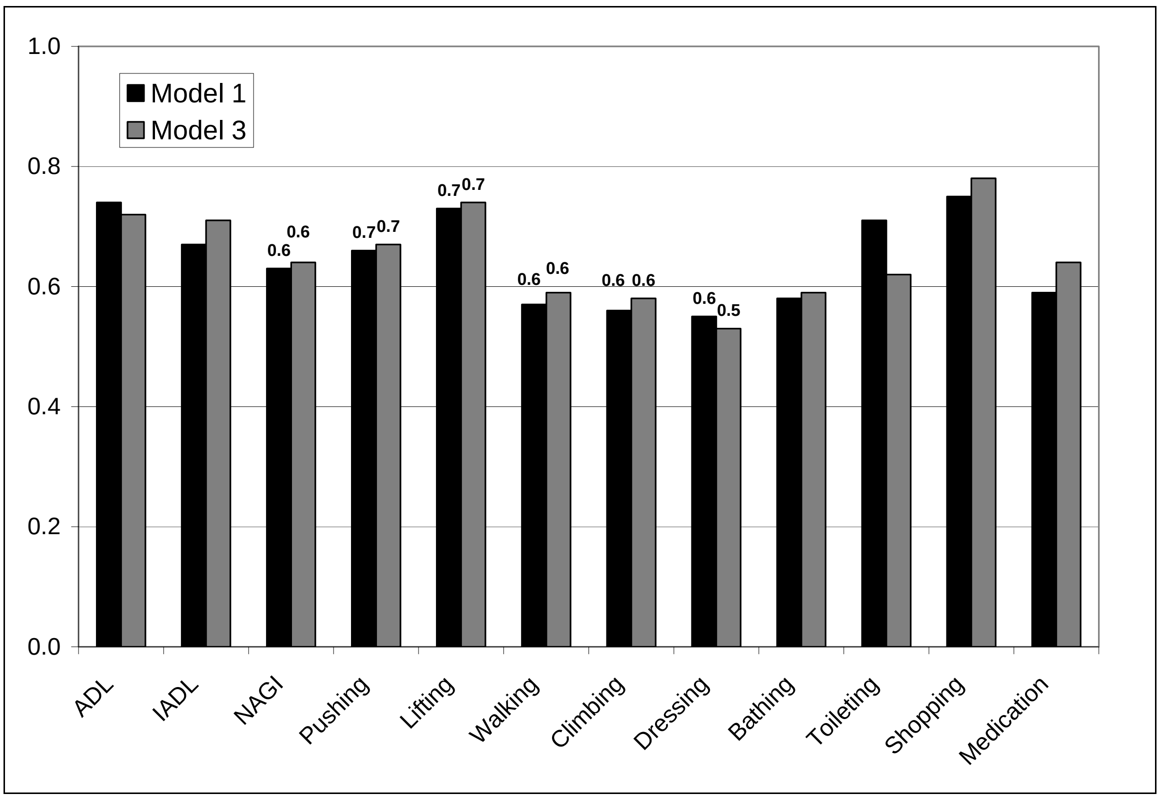
Note: ** p<0.01 and * p<0.05

Table 16: Test of hypothesis 3: Recovery from physical and functional limitations is lower among diabetics than non-diabetics, MHAS

	Model 1		Model 3		Sample size
Pushing	0.66**	[0.51 - 0.85]	0.67**	[0.51 - 0.87]	1471
Lifting	0.73*	[0.56 - 0.94]	0.74*	[0.57 - 0.96]	1384
Walking	0.57**	[0.44 - 0.73]	0.59**	[0.45 - 0.76]	1687
Climbing	0.56**	[0.45 - 0.69]	0.58**	[0.47 - 0.73]	2979
Dressing	0.55*	[0.34 - 0.88]	0.53**	[0.33 - 0.86]	433
Bathing	0.58	[0.33 - 1.02]	0.59	[0.32 - 1.07]	285
Toileting	0.71	[0.40 - 1.24]	0.62	[0.34 - 1.13]	295
Shopping	0.75	[0.48 - 1.17]	0.78	[0.49 - 1.22]	441
Medication	0.59	[0.24 - 1.47]	0.64	[0.24 - 1.71]	149

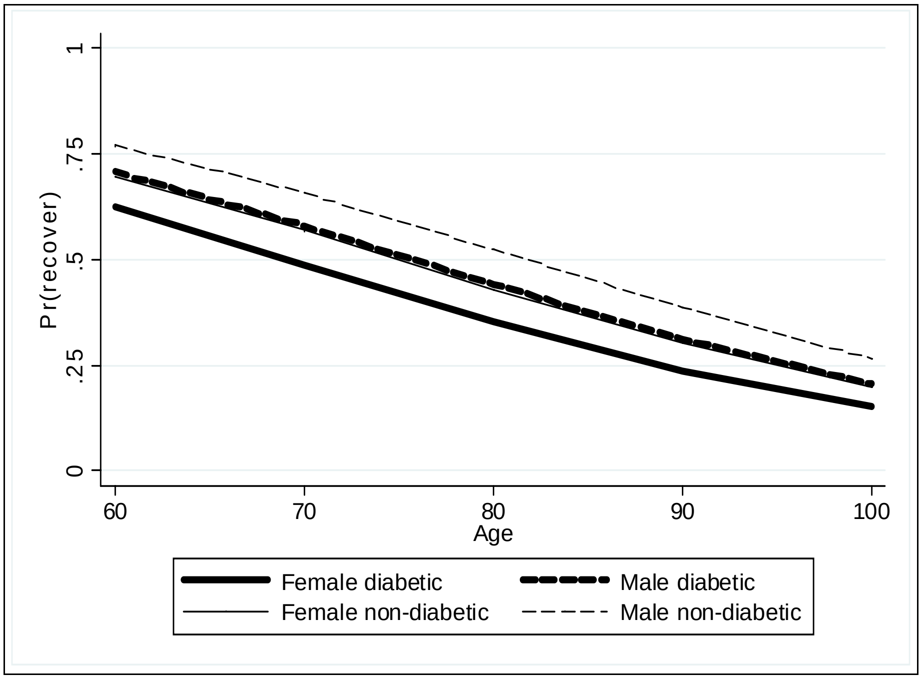
Note: ** p<0.01 and * p<0.05

Graph 12: Test of hypothesis 3: Recovery from physical and functional limitations is lower among diabetics than non-diabetics, MHAS

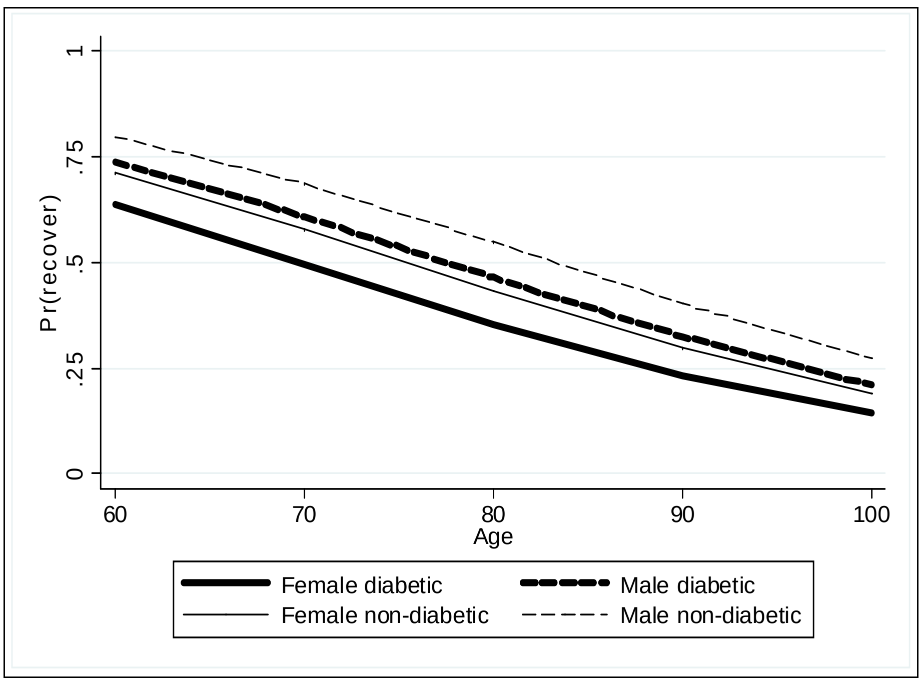


Note: Highlighted values are statistically significant at p<0.05.

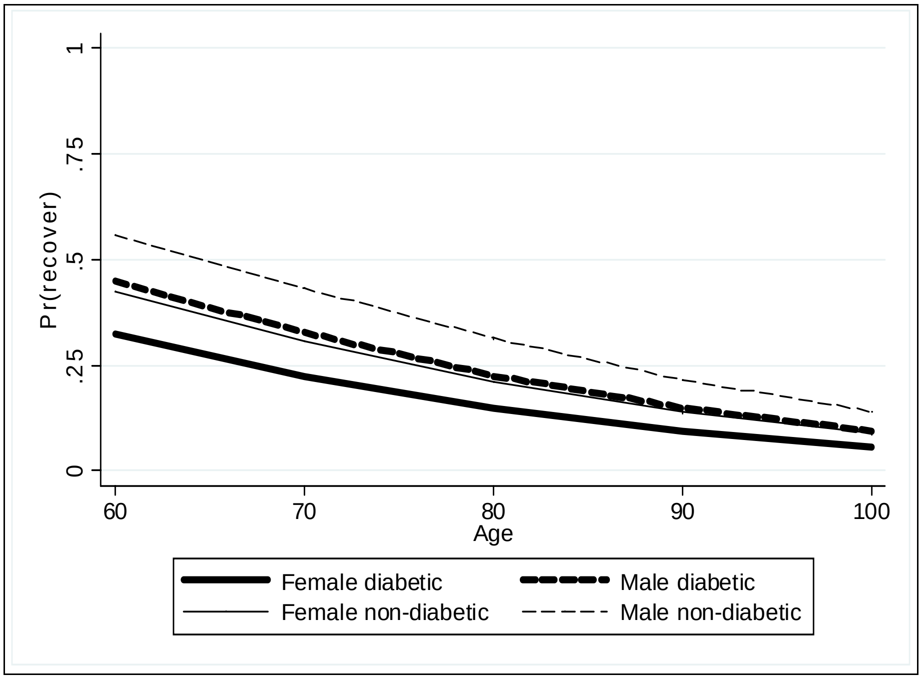
Graph 13: Predicted ADL recovery by age and sex, MHAS



Graph 14: Predicted IADL recovery by age and sex, MHAS



Graph 15: Predicted NAGI recovery by age and sex, MHAS



Diabetes increases the risk of having worse health outcomes

Diabetes is prevalent condition in Mexico that it is associated with increased morbidity and mortality risks. Data from MHAS show that diabetes effects on heart disease are positive, but not statistically significant (Table 17), but the risk of having a stroke in a two-year period is 2.3 to 2.8 times higher among Mexicans with diabetes (Table 18).

Diabetes is well-known risk factor for increased all-mortality and cardiovascular disease mortality in developed countries (de Vegt et al. 1999, Morgan, Currie and Peters 2000, Berger, Stenström and Sundkvist 1999), but less is known about the diabetes excess mortality risk in Latin American countries. Data from MHAS shows that, in Mexico, diabetes alone doubles the mortality risks for all causes (Table 19 and Graph 16).

Table 17: Test of hypothesis 4: Odds of developing heart disease in a two-year period is higher among diabetics, MHAS

Variables	Model 1		Model 3	
Age	1.01	[0.99 - 1.04]	1.01	[0.99 - 1.04]
Female	0.89	[0.63 - 1.26]	0.65*	[0.44 - 0.96]
Diabetes	1.49	[0.98 - 2.27]	1.25	[0.82 - 1.91]
HBP			2.81**	[1.93 - 4.08]
Stroke			0.80	[0.29 - 2.21]
Cancer			1.67	[0.60 - 4.65]
Lung disease			0.60	[0.26 - 1.39]
Arthritis			1.09	[0.73 - 1.61]
Never smoked			1.31	[0.89 - 1.94]
Observations	5823		5823	

Note: ** p<0.01 and * p<0.05

Table 18: Test of hypothesis 4: Odds of having a stroke in a two-year period is higher among diabetics, MHAS

Variables	Model 1		Model 3	
Age	1.05**	[1.02 - 1.08]	1.05**	[1.02 - 1.08]
Female	1.36	[0.83 - 2.21]	0.97	[0.56 - 1.70]
Diabetes	2.76**	[1.67 - 4.56]	2.28**	[1.37 - 3.79]
HBP			2.99**	[1.74 - 5.15]
Heart			1.10	[0.43 - 2.82]
Cancer			0.68	[0.09 - 5.01]
Lung disease			1.43	[0.67 - 3.06]
Arthritis			1.54	[0.94 - 2.52]
Never smoked			1.26	[0.73 - 2.18]
Observations	5888		5888	

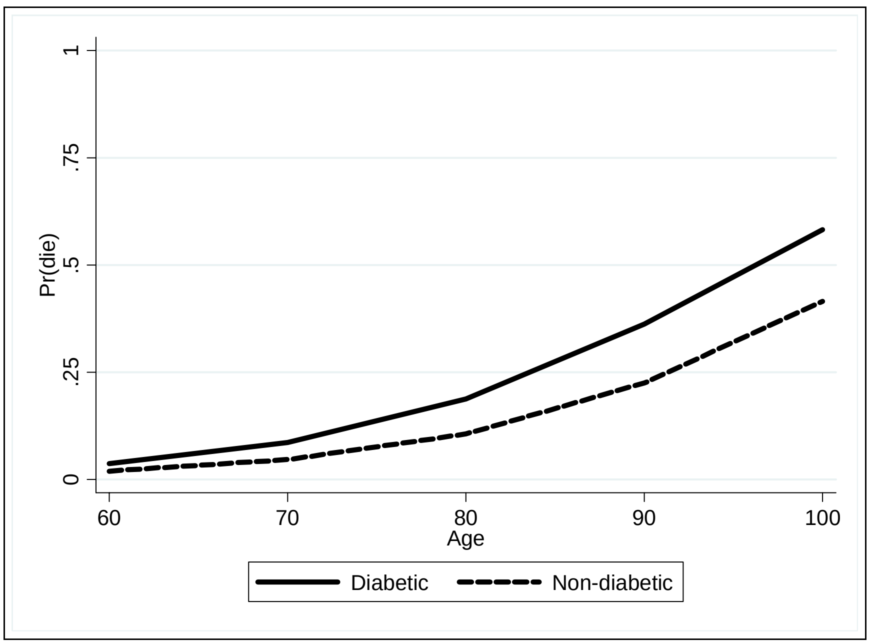
Note: ** p<0.01 and * p<0.05

Table 19: Test of hypothesis 4: Mortality risk is higher among diabetics, MHAS

Variables	Model 1		Model 3	
Age	1.09**	[1.08 - 1.11]	1.09**	[1.08 - 1.11]
Female	0.75**	[0.62 - 0.92]	0.83	[0.66 - 1.04]
Diabetes	2.09**	[1.66 - 2.63]	1.96**	[1.54 - 2.49]
HBP			1.14	[0.92 - 1.41]
Heart			1.49*	[1.02 - 2.18]
Stroke			2.61**	[1.82 - 3.75]
Cancer			2.76**	[1.66 - 4.60]
Lung disease			1.83**	[1.35 - 2.49]
Arthritis			0.89	[0.70 - 1.12]
Never smoked			0.82	[0.66 - 1.03]
Observations	6561		6561	

Note: ** p<0.01 and * p<0.05

Graph 16: Test of hypothesis 4: Higher mortality risks among diabetics by age, MHAS



Final remarks

This paper demonstrates that diabetes is associated higher functional disability in the Latin America and the Caribbean, which significantly impairs the quality of life and imposes important social and economic costs for these populations. Recent data from two large surveys conducted in seven countries in Latin America and the Caribbean are used to examine the prevalence and incidence of physical and functional disability associated with diabetes among elderly individuals. The use of these recent surveys provides a unique opportunity to examine the relationship between diabetes and functional disability prevalence, incidence and recovery. This is particularly important because the Latin American and Caribbean population is aging fast and diabetes prevalence is expected to rise in the next decades. Diabetes prevalence is extremely high in some of these countries and the economic and social costs are substantial. A recent study conducted by Barceló and colleagues (2003) showed that the total annual cost associated with diabetes was estimated in more than US$65 billion. The indirect costs contributed to 82% of the overall costs. Indirect costs are due over 330,000 deaths occurring in year 2000 (over 757,000 years of productive life lost) and to approximately 178,000 individuals with permanent disability (over 136,000 years of productive life lost). Diabetes is also associated with increased use of health care. The direct costs (drugs, consultations and hospitalizations) represented 18% of the overall costs and are estimated at US$703 per capita annually. These values are incredibly high per se, but they are even more striking if we consider that direct costs alone represent 19% of the total per capita gross national income in the region.

Residents in Santiago (Chile), São Paulo (Brazil) and Mexico City (Mexico) report high prevalence rates of ADL, IADL and NAGI activities, while considerably lower rates are found in Bridgetown (Barbados) and Montevideo (Uruguay). Even after age, sex and other health conditions are taken into account, significant differences remain across cities. Mexicans also report high prevalence of functional disability.

The analysis of descriptive data shows that those with diabetes have higher prevalence of limitations on activities of daily living and instrumental activities of daily living in all analyzed settings. At the same time, diabetics have higher prevalence of comorbid conditions. Diabetics are also heavier than those without the disease.

In accordance with the previous literature, this study shows that diabetics have a higher likelihood of having functional disability than those never diagnosed with the disease. The previous literature has found that diabetes increases by two to three times the likelihood of having disability (Gregg et al. 2000, Gregg et al. 2002, Ryerson et al. 2003). In this study, the risk of having ADL is increased by 50-100% among diabetics versus non-diabetics. The prevalence of IADL is about 1.5 to 2.3 times higher among diabetics. In the analyzed Latin America and the Caribbean settings, the odds of having NAGI limitations are 1.5 to 2.0 higher among diabetics versus non-diabetics. Diabetics are also more likely to be severely impaired than non-diabetics. In Buenos Aires, São Paulo, Havana and Mexico the risks of having difficulties performing at least 3 ADLs is 60-120% higher among diabetics. However, obesity mediates a good amount of this additional burden. The risks of having severe IADL limitations among diabetics are 2.5, 2.6 and 2.9 times higher than among non-diabetics in Santiago, Bridgetown and Mexico, respectively. The odds of having difficulties performing at least 3 NAGI activities are 1.4 to 2 times higher among diabetics. After considering the mediating effect of obesity, diabetics still face risks about 1.5 to 2 times higher than non-diabetics in Havana, Santiago, Mexico City, Montevideo and Mexico.

Diabetics have much more difficulty performing activities such as bathing, toileting, shopping and walking several blocks than non-diabetics. These limitations considerably reduce the independence and well-being of those individuals. Usually, bathing becomes more difficult and more hazardous for elderly individuals, but the odds of having difficulties bathing themselves are considerably increased in those with diabetes – varying from 50-140% increase.

This inability to bath independently makes individuals dependent on others to maintain their personal cleanliness. Just going to the bathroom is challenging for some elders with mobility difficulties and falls in the bathroom is another concern of elderly individuals. But for those who can reach the bathroom toileting can still be challenging. Many elders have difficulty twisting and reaching the toilet. Diabetics are 1.6 to 2.2 times more likely to report having difficulties using the toilet than non-diabetics. Mobility issues also impose more difficulties for diabetics to do grocery shopping and to walk several blocks. These mobility limitations remain higher for diabetics even after arthritis is taken into account. The risk of having difficulties performing these activities is 50-110% higher among diabetics in Latin America and the Caribbean.

The study also shows that there is a higher incidence of functional disability among diabetics in Mexico. Gregg et al. (2002) has previously reported that diabetes was associated with an increase of 42% in the risk of any incident disability among white elderly women even after controlling for comorbidities and potential confounders. This study followed a similar approach and confirmed that diabetes has an even stronger association, for both men and women, with the incidence of functional disability in Mexico. Data from MHAS indicates that the risk of developing ADL is more than 70% higher among diabetics than non-diabetics. The effect of having diabetes on the incidence of ADL remains positive even after considering the disabling effects of obesity. However, the coefficients are no longer significant as the sample size is significantly reduced. Individuals with diabetes at baseline are about 2-3 times more likely to develop IADL in a two-year period than non-diabetics. The risk of becoming physically limited (NAGI) is increased by more than 50% for those with diabetes, even though the coefficient is not significant when obesity is taken into account.

Data from Mexico confirms the findings from Jagger et al. (2003) that showed that those with diabetes experience a lower likelihood of recovery from inactive to active. Results from MHAS indicate that diabetics are about 40% less likely to recover from NAGI limitations than non-diabetics. Sample sizes are even smaller if obesity is taken into consideration, and odds ratios are not anymore significant, but they remain under 1.

Diabetics considerably less likely to recover from difficulties performing activities such as pushing a heavy object, lifting about 10 pounds, walking several blocks, climbing several steps or dressing themselves. The chances of recovering from disability decline significantly with age. Women are also considerably less likely to recover from ADL, IADL or NAGI limitations than men.

Diabetes is prevalent condition in Mexico that it is associated with increased morbidity and mortality risks. Data from MHAS show that the risk of having a stroke in a two-year period is 2.3 to 2.8 times higher among Mexicans with diabetes than among their non-diabetic counterparts. Diabetes is well-known risk factor for increased all-mortality and cardiovascular disease mortality in developed countries (de Vegt et al. 1999, Morgan, Currie and Peters 2000, Berger, Stenström and Sundkvist 1999), but less is known about the diabetes excess mortality risk in Latin American countries. Data from MHAS shows that, in Mexico, diabetes alone doubles the all-cause mortality risk.

The results found in this study cannot be generalized for those with undiagnosed diabetes. In fact, since data depends on self-report, the effects measured here may be somewhat biased. If one assumes that the prevalence of disability is higher among those with undiagnosed diabetes, than among truly non-diabetics, then the self-reported measures may lead underestimated the association between diabetes and disability.

In sum, this study shows that diabetics face higher risks of having and developing limitations on their daily life activities that considerably reduces their quality of life. Diabetics are also less likely to recover from disability, which makes them more vulnerable for a larger percentage of their remaining lives. The mortality risks are also considerably higher among diabetics. The governments and public health institutions in these countries should target diabetic individuals in order to reduce the disability and mortality costs as a way to improve the quality to life for persons with diabetes.

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