Association of Major Depression and Diabetes in Medically Indigent Puerto Rican Adults

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Background: Studies have found that major depression and diabetes mellitus are strongly associated. The main goal of this study was to evaluate the association between major depression and diabetes in a large medically indigent population of Puerto Rican adults living on the island.

Methods: A secondary database analysis through a cross-sectional design was used for this study. Participants were selected from the Puerto Rico Commonwealth Health Plan database, beneficiaries of the public health sector. Adult's subjects with at least one claim during 2002 were included. The final sample consisted of 1,026,625 adult insured. The International Classification of Diseases (ICD-9) was used for disease classifications.

Results: The prevalence of diabetes was 14.6% in subjects with major depression and 9.7% for those without major depression (POR 1.59, p<0.001). The strength of this association remained after adjusting for obesity and sex.

Conclusions: Prevalence of diabetes appears to be significantly higher in Puerto Rican adults with major depression compared to those without this psychiatric disorder. Longitudinal prospective studies and randomized controlled trials are needed to shed light on the temporal or causal relationship and to test whether effective prevention and treatment can reduce the risk of developing diabetes. [*P R Health Sci J 2010;1:30-35*]

Key words: Major depression, Diabetes, Puerto Rico

Studies have found that people with diabetes in the United States have a greater risk of presenting serious psychological disorders than individuals without diabetes (1-2). Some psychiatric disorders that have been associated with diabetes are depression, anxiety, and schizophrenia. Depression and anxiety in patients with diabetes convey an additive physical and mental health risk since they have been found to be significantly related to hyperglycemia and an increased risk for complications (2-5).

There is ample evidence in the literature that depression is highly prevalent in patients with diabetes (5-6). Anderson and his colleagues conducted a meta-analysis to review 42 studies on the co-morbidity between diabetes and depression. Results of this study suggest that individuals with diabetes have twice the risk of suffering from depression than people without diabetes (5).

Several hypotheses might explain the possible relationship between diabetes and the increased prevalence of certain psychiatric disorders (7). One of the simplest theories view the development of a psychiatric disorder as the result of the psycho-social stressors associated with having and managing a complex and demanding chronic condition such as diabetes. Over time diabetes can become a chronic stressor and the number of complications a patient develops can, over time, negatively affect quality of life.

It is clearly stated that diabetes and depression often go hand in hand. However, it's been unclear which condition develops first in patients who end up with both. Several studies have suggested that people who suffer from a depressive episode are at greater risk of developing diabetes subsequently (5, 7-10) and that the development of a depressive disorder precedes the diagnosis of type 2 diabetes by many years (11-12). Recently, studies have been focusing more on biological explanations to explain the increased risk of developing diabetes in patients with psychiatric disorders. Various physiological explanations have been offered ranging from the increase in insulin resistance and reduction of glucose uptake resulting from depression contributes to the destabilization of a pre-existing precarious metabolic balance in individuals at risk (7) to increased activity

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in the hypothalamic-pituitary-adrenocortical (HPA) axis and sympathetic nervous system (8).

Alternately, it has been found that people with major depression or anxiety tend to have poorer health behaviors (unhealthy diet, smoking, sedentary lifestyles) which are risk factors for obesity and diabetes. Symptoms associated with psychiatric disorders such as depressed mood, excessive anxiety, fatigue, anhedonia, insomnia and loss of contact with reality can in turn, negatively impact healthy lifestyle behaviors such as diet and exercise, thus increasing the risk of developing diabetes (7, 13).

Another factor that is strongly associated with diabetes is obesity. There is overwhelming evidence that obesity is a risk factor for type 2 diabetes and not just related to overall weight, but also to the distribution of excess weight. It is estimate that up to 90% of all type 2 diabetes cases are associated with excess weight and obesity, particularly with abdominal adiposity (14).

Research studies on psychiatric disorders in racially and ethnically diverse people with diabetes are scarce, and even in studies conducted in the United States, few report the race and/or ethnicity of participants (5). Puerto Rico has a high prevalence of psychiatric disorders with an estimated 28% for the year 2000 (15), as well as the highest prevalence of self-reported diabetes in the United States (14). The main goal of this study was to evaluate the association between major depression and diabetes mellitus in a large population of Puerto Rican medically indigent adults living on the island.

Methods

This study was based on a secondary administrative database analysis. In most situations, administrative data may have several advantages over traditional survey data, including more complete coverage of a population, low data collection costs, reduced respondent burdens, and better data quality. The potential problems with using administrative data for statistical purposes include privacy concerns about non-administrative use of data, conceptual issues relative to the population and items collected, and costs of transforming the data into a form useful for research purposes (16).

A cross-sectional design was used for this study. The database used was provided by the Puerto Rico Administration of Health Services (ASES, for its abbreviation in Spanish) which keeps cumulative records of the Puerto Rico Commonwealth Health Plan (PRCHP) claims. This database contains physicians and hospital claims, so the diagnostic codes were applied in the community and in the hospital setting.

This health plan serves the public health sector with more than 1.6 million medically indigent insured's. Usually and as result of the government regulations and complexity, it takes approximately 2 years, after the end of each the natural year, to clean, revise and produce a final database of reasonable quality. At the time of this study, only the 2002 database were available to researchers; thus, only claims generated during the 2002 natural year were selected and managed for this study. Local and Federal privacy laws limits the amount of information that government administrative databases can provide to external people. The only demographic variables that ASES agree share for study were age and sex. For the morbidities, the International Classification of Diseases codes Ninth Revision, Clinical Modification (ICD-9-CM) were available (17). The total of PRCHP beneficiaries for 2002 was 1,623,269 residents of Puerto Rico.

The PRCHP insured's generated 2,586,736 claims for the 2002 natural year. All these claims were aggregated and consolidated into one database with a unique identification number. This identification number was a dummy variable generated by ASES and did not include any identifying information. All insured's with at least one PRCHP claim during 2002 were initially selected. Finally, due to the low prevalence of diabetes and mental diseases in children, only adults 18 years or older were included (1,026,625 adults).

Three disease categories were created: diabetes, major depression, and obesity. For each category, the prevalence estimates, for the natural year 2002, were calculated using the following period prevalence formula:

$$\text{Prevalence} = \frac{\text{number of adults with at least one claim for the selected category during 2002}}{\text{total population of adults insured's in 2002}} \times 100$$

As noted in the formula above, for each category only one claim within the natural year 2002 was enough to generate the prevalence estimates. Using only one year data to obtain prevalence estimates may result in an underreported estimates compared with several years or lifetime estimates (18). Also, Odds ratios are generally greater for 12-month disorders than for lifetime disorders (19-20). However, in psychiatric disorders, associations usually remain strong and statistically significant regardless the prevalence time span (21). The following ICD-9 codes were used for the construction of each disease category: Diabetes mellitus (250.XX), Major depression (296.2X - 296.3X), and Obesity (278.0X); each X in the codes could be any number between 1 and 9.

Although less involved than the centralization of body fat, the Body Mass Index (BMI) is correlated with depression symptoms (22). Because our administrative database did not have information about BMI we use the obesity ICD-9 as an indicator of a high BMI and as a control variable. Other control variables such as economic and education levels were not included because they were not available in this administrative database. However, because the benefits of this government health plan are available only to low socioeconomic groups certain homogeneity is presume regarding this dimension.

The process and criteria used by clinician's to assign the ICD codes is complicated but the basic process is typical, even though details of any given step at any given facility may vary. Basically, the clinicians could assign the ICD codes from the initial patient exploration and preliminary diagnosis to the final test results and final diagnosis, a process typically know as the patient trajectory. This means that a patient could have one or many diagnosis that can or cannot be similar. Another related process is the paper trail where the clinician and/or his staff revise and transcript ICD and other code types (23).

Logistic regression models were used to evaluate the association between diabetes and major depression, obesity, sex and age. All the analyses were performed using the SPSS statistical software package version 15.0 (SPSS Inc., 1989- 2006, IL, Chicago).

Table 1. Age and sex distribution of participants (n = 1,026,625)

Variable	n	Percent (%)
Age group		
18 – 34	354,936	34.5
35 – 54	326,902	32.0
55 – 74	253,631	24.7
> 74	91,156	8.9
Sex		
Female	630,348	61.4
Male	396,277	38.6

Table 2. Disease groups distribution (n = 1,026,625)

Disease group	n	Percent (%)	95% CI
Diabetes	100,609	9.8	9.7 – 10.1
Major depression	31,825	3.1	3.2 – 3.3
Obesity	51,331	0.5	0.4 – 0.6

Results

The participant's sex and age distributions showed a higher percentage of females (61.4%) than males (38.6%). The distribution by age groups was as follows: 18 – 34 (34.5%), 34 – 54 (32.0%), 55 – 74 (24.7%), and 75 and older (8.9%). Of all the three disease groups, diabetes showed the highest prevalence with 9.8% (96% CI: 9.7% - 10.1%), followed by major depression with 3.1% (95% CI: 3.2% - 3.3%). Obesity resulted in the lowest prevalence category with 0.5% (95% CI: 0.4% – 0.6%) (Table 1 and Table 2).

The diabetes prevalence by sex showed a statistically significant ($p<0.001$) higher percentage for females (10.1%) than males (9.7%). Also, the prevalence of major depression and obesity were statistically significant ($p<0.001$) higher in the female groups (3.3% versus 2.8% and 0.6% versus 0.3%, respectively). The prevalence of diabetes showed a tendency to increase by age with a peak at the 55 – 64 age group (19.2%). The peak for major depression was observed at the 45 – 54 age group (5.7%). On the other hand, obesity showed a tendency to decrease by age with a peak at the 25 – 34 age group (0.8%) (Figures 1, 2, and 3).

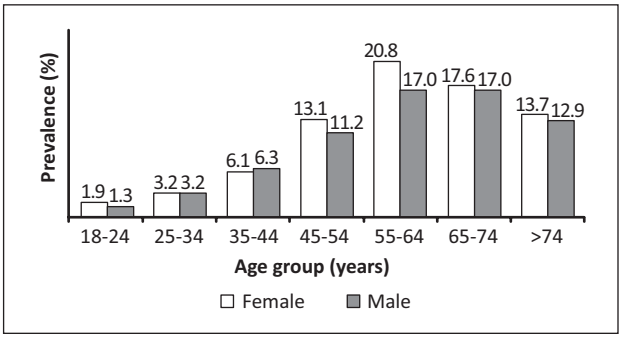

Figure 1. Prevalence (%) of diabetes by age and sex in Puerto Rican adults, 2002 (n=1,026,625)

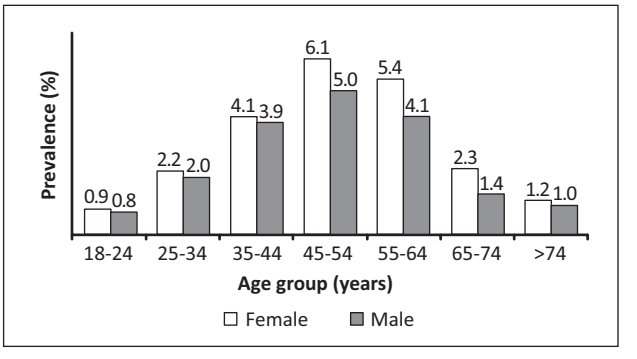

Figure 2. Prevalence (%) of major depression by age and sex in Puerto Rican adults, 2002 (n=1,026,625)

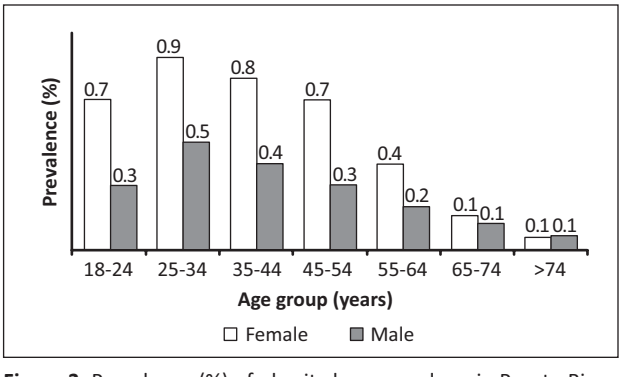

Figure 3. Prevalence (%) of obesity by age and sex in Puerto Rican adults, 2002 (n = 1,026,625)

The unadjusted prevalence of diabetes was 14.6% (95% CI: 14.2% - 15.0%) in subjects with major depression and 9.7% (95% CI: 9.5% - 9.9%) for those without major depression.

This 4.9 prevalence point difference was statistically significant (p<0.001) with an unadjusted prevalence odds ratio (POR) of 1.6 (95% CI: 1.5 – 1.6). For subjects with obesity, the unadjusted prevalence of diabetes was 13.5% (95% CI: 12.5% - 14.4%) and 9.9% (95% CI: 9.7% - 10.0%) for those without obesity with a statistically significant association at a 0.001 level.

To estimate the diabetes POR for major depression, considering the possible effects of age, sex and obesity as independent variables, logistics procedures were applied. Significant interactions (p<0.001) were found between age*sex, and age*obesity. Therefore, for each of the four age groups (as defined in Table 1) a specific logistic model was executed. Except for sex in the older age group, major depression, obesity, and sex were statistically significant in the stratified regression models. The adjusted diabetes POR for major depression ranged from 1.2 (95% CI: 1.1 – 1.3) for the 55 – 74 age group to 2.0 (95% CI: 1.7 – 2.4) for the 18 – 34 age group. In terms of obesity as an associated factor the lowest adjusted POR was observed for the 55 – 74 age group (1.7, 95% CI: 1.4 – 2.0) and the highest adjusted POR was observed for the 18 – 34 age group (2.8, 95% CI: 2.3 – 3.3). For the sex variable the results were very similar for each age group with a POR raging from 1.0 to 1.1 (Table 3).

Table 3. Prevalence Odds Ratio for diabetes by co-morbid factors and by age groups in Puerto Rican adults, 2002

Age Group (years)	Major Depression POR (95% CI) p-value	Obesity POR (95% CI) p-value	Sex POR (95% CI) p-value	n
18 - 34	2.0 (1.7 - 2.4) p<0.001	2.8 (2.3 - 3.3) p<0.001	1.1 (1.0 - 1.1) p=0.001	354,936
35 - 54	1.5 (1.4 - 1.5) p<0.001	1.8 (1.6 - 2.0) p<0.001	1.0 (0.9 - 1.0) p<0.001	326,902
55 - 74	1.2 (1.1 - 1.3) p<0.001	1.7 (1.4 - 2.0) p<0.001	1.0 (1.0 - 1.1) P=0.003	253,631
> 74	1.3 (1.1 - 1.6) p<0.001	3.7 (2.1 - 6.6) p<0.001	1.0 (0.9 - 1.0) p=0.152	91,156

Discussion

Analogous to the literature review this study found a high prevalence of diabetes mellitus in this sample of the Puerto Rican adult population (14). This prevalence is very similar to the prevalence reported by the Behavioral Risk Factor Surveillance System in 2002 (24) for the Puerto Rican adult population (10.5%, 95% CI: 9.4% - 11.6%). In fact, this surveillance system prevalence showed a tendency to keep rising and in 2005 it reached 12.5% (25).

The prevalence of major depression in this study is slightly lower (3.1%) than the estimate presented by Avilés and colleagues (15) for the year 2000 for Puerto Ricans (4.5%). The prevalence and distribution of major depression derived from the National Comorbidity Survey (NCS) of 1994 was 4.9% for people of all races/ethnicities over 15 years of age. However, the NCS results for the Hispanic group aged 25 years or older, a better comparable cluster considering the population in this study, showed lower prevalence between 3.0% and 3.7% (26).

In general, differences between the outcomes from this study and the outcomes from national studies with similar target populations could be a result of how each source defines a positive case for each condition. Some national surveys, such as the Behavioral Risk Factor Surveillance System (BRFSS), use self-reported information and the case classifications becomes a "believing in what the interviewee said" issue. This could result in people classifying themselves as ill or healthy when they aren't and vice-versa. For example, in the BRFSS a subject could said that he has been diagnosed with diabetes by a doctor when in reality he was just diagnosed with insulin resistance but not with diabetes. Other possible explanations are differences in the sizes, power and representativeness of the sample.

This obesity prevalence observed here is extremely inferior to the expected prevalence as reported by the BRFSS in 2002 for the Puerto Rican adult population (22.0%, 95% CI: 20.4% - 23.5%) (27). This huge difference could be explained by a tendency to underreport the obesity diagnosis by the physicians and the lack of the ICD-9 coding system for specific codes for all procedures currently related to weight loss (28).

The statistically significant differences in major depression and obesity by sex, evidencing higher percentages for the female groups, have been also reported by other researchers, especially in Hispanics or non-white populations. (29). On the other hand, diabetes prevalence's differences by sex resulted statistically significant. Although the majority of literature research for this population recognizes small differences in diabetes prevalences by sex, most of it report not statistical significantly differences (30). A possible explanation for this could be the huge sample size. Large sample sizes could produce small p-values even when differences between groups are not meaningful (31).

Although the data used is a snapshot of a moment in time, and we do not have information about the possible consistency of the findings in former or upcoming years, the disease-age distributions and the peaks of prevalences in certain age groups bring some idea of those with greater probability of disease. These distributions and peaks reveal greater probability of diabetes in the middle-late ages and greater probability of depression between the fourth and the fifth decade of life; for obesity, the greatest probability could be observed in the early years. Therefore, these groups of Puerto Ricans should be the main target of treatment and services.

The significantly higher prevalence of major depression in the group with diabetes compared to the group without diabetes in our sample is consistent with many studies that have found a significant association between major depression and

diabetes mellitus. Talbot and Nowen (9) found support for the hypothesis that psychological variables specific to diabetes are associated with the presence of depressive symptoms in patients with diabetes. This study suggests that there are variables (i.e. perception of the intrusion of diabetes in daily life, social support, the loss of health and coping styles) that mediate the relationship between diabetes and depression. We found that 14.6% of Puerto Rican adults with major depression had diabetes. This percentage appears to be very high when compared to the results of a case-control study conducted by Brown et al., in 2005 that evidenced a 4.9% prevalence of diabetes in a Canadian sample of adults with a history of major depression (32).

The higher odds of diabetes in individuals with major depression is consistent with the results of a meta-analysis published by Knol et al., in 2006 that found pooled relative risks of 1.26 (95% CI: 1.13 – 1.39) and 1.37 (95% CI: 1.14-1.63) using a random effects model (8). In addition, Brown and colleagues (2005) also found odds ratios with similar magnitudes rising between 1.10 and 1.37 for adult subjects (32).

The results of the logistic regressions showed that major depression could be a significant associated factor for diabetes in all age groups, even after adjusting for obesity and sex. In general, the adjusted odds of major depression exhibits a tendency to decrease as age increased. As expected, obesity was found to be a strong associated factor even after adjusting for major depression and sex. This obesity factor is stronger for Puerto Ricans over 74 years of age compared to all the other age groups. Although, sex was a statistically significant variable for those aged less than 75, the odds ratios magnitudes were not significant. However, the effect of obesity in the model may be questioned for its validity due to underestimation. Therefore, an attenuation of the OR magnitude may be possible.

This study has some strengths and limitations that must be considered. The strengths include a large population-based sample and the relative homogeneity in socio-economic status of the subjects (is closer to representing the population rather than a mere sample). The major limitation in this study is that temporal sequence can't be established. Another aspect to consider is the sensitivity for identifies each disease. Although investigations examining the sensitivity of administrative data for identifying various other diagnoses have found sensitivities in the range of 57% to 93% with the majority reporting values greater than 80%, for the current study, we did not validate this (33).

Errors regarding the ICD codes accuracy may also be considered a limitation because, as in many secondary databases, the researcher has no control of this issue. Many sources of error are interposed between a person's disease and the word label or diagnosis applied to it by a clinician, and between the diagnosis and the nosologic code applied to it by a medical coder. Some of these possible sources of error are: patient-clinician communication, quality of available tests, clinician knowledge and experience, transcription techniques, and clinician attention to details, among other possible errors (23).

In conclusion, the diabetes prevalence appears to be significantly higher in Puerto Ricans with major depression compared with those without this psychiatric disorder. This study provides new estimates of diabetes and depression prevalence, which, given the extremely large sample size (which is actually the whole target population and not a sample), may be more accurate than estimates based on smaller sample sizes surveys. Therefore, this work is an important addition to the literature. Longitudinal prospective studies and randomized controlled trials are needed to shed light on the possible temporal or causal relationship between diabetes and depression and to test whether effective prevention and treatment can reduce the risk of developing diabetes.

The results of this study also have some important clinical implications for health care in Puerto Rico. They underline the importance of routine screening for depression in patients with diabetes, as well as routine screening for diabetes in patients with depression in order to reduce the morbidity and mortality of these diseases through early detection and treatment. The presence of a co-morbid psychiatric disorder such as depression in patients with diabetes can negatively affect adherence to diabetes treatment as well as health outcomes which is why early detection and treatment by an integrated interdisciplinary health care team are so important.

Resumen

Introducción: Estudios han encontrado que la depresión mayor y la diabetes mellitus están altamente relacionadas. La meta principal de este estudio fue evaluar la asociación entre la depresión mayor y la diabetes en un grupo de adultos puertorriqueños, médicamente indigentes, que residen en la isla. Métodos: Para éste estudio se utilizó un análisis secundario de datos a través de un diseño transversal. Los participantes fueron seleccionados de la base de datos del Plan de Salud del Estado Libre Asociado de Puerto Rico, el cual sirve al sector público. Se incluyeron beneficiarios adultos con al menos una reclamación durante el año 2002. La muestra final consistió de 1,026,625 adultos asegurados. El Código Internacional para la Clasificación de Enfermedades (ICD-9, por sus siglas en inglés) fue utilizado para identificar y clasificar a los asegurados con reclamaciones por diabetes y por depresión mayor. Resultados: La prevalencia de diabetes fue de 14.6% en pacientes con depresión mayor y 9.7% para pacientes sin depresión mayor (POR 1.59, $p<0.001$). La fuerza de esta asociación se mantuvo luego de ajustar por las variables de obesidad y sexo. Conclusiones: La prevalencia de diabetes parece ser significativamente más alta en los adultos puertorriqueños con depresión mayor en comparación con los adultos que no padecen de éste trastorno psiquiátrico. Estudios prospectivos y ensayos clínicos son necesarios para brindar más información sobre la relación causal o temporal, y para determinar si la prevención y el tratamiento adecuado pueden reducir el riesgo de desarrollar diabetes.

Abbreviations

ASES - Puerto Rico Administration of Health Services, BMI - Body Mass Index, BRFSS - Behavioral Risk Factor Surveillance System, ICD-9 - International Classification of Diseases, NCS - National Comorbidity Survey, POR - Prevalence Odds Ratio, PRCHP - Puerto Rico Commonwealth Health Plan

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