How Does Change in Depressive Symptomatology Influence Trajectories in Weight, Behaviors and Cognitive Function in Adults with Diabetes?

Authors:

Ching-Ju Chiu¹, Ph.D.
Feng-Hwa Lu¹², M.D., M.S.
Yang YC¹², M.D., M.S.
Wu JS¹², M.D., Ph.D.
Siao-Ling Lee¹, B.S.
Linda A. Wray³, Ph.D.
Elizabeth A. Beverly⁴, Ph.D.

¹Institute of Gerontology, College of Medicine, National Cheng Kung University, Tainan, Taiwan
²Department of Family Medicine, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan
³Department of Biobehavioral Health, Pennsylvania State University, University Park, PA, United States
⁴Joslin Diabetes Medical Center, Harvard Medical School, Boston, MA, United States
ABSTRACT

The overall purpose of this study was to investigate longitudinal associations between changes in depressive symptoms and trajectories in weight, cognitive function and health behaviors. Data on 392 patients with diabetes (mean age 67, SD=8.3) from the Taiwan Longitudinal Study on Aging was used. Mixed effect regression analyses compared a) patients with persistently low depressive symptoms with those whose depressive symptoms increased (at least 5 points on CES-D) over 7 years from 1996 to 2003 and b) patients with persistently high depressive symptoms with those whose symptoms decreased (at least 5 points on CES-D) from 1996 to 2003 on their levels of and rates of change in weight, exercise, and cognitive function during 1999, 2003 and 2007. Compared to those with persistently low depressive symptoms, those whose depressive symptoms increased did not differ in their patterns of cognitive function, but they had a significantly faster increase in BMI and decrease in amount of exercise they participated in. Although the groups had almost identical cognitive function at baseline, those whose depressive symptoms decreased had a significantly lower rate of decline in cognitive function compared to those with persistently high depressive symptoms. We concluded that weight management and maintain of healthy behaviors may be jeopardized by increment in depressive symptoms even for those with low depressive symptoms at baseline. In persons with diabetes who have high score of depressive symptoms, improvement in depressive symptomatology may guard against cognitive deterioration. The management of psychological burden in adults with diabetes cannot be overemphasized.

Key words: Diabetes, Depression Symptoms, Weight, Cognitive Function, Health Behavior
Diabetes is a prevalent chronic disease. Currently, about one in ten people of all ages and more than 20% of older adults aged 65 and above, are living with diabetes (citation). While prevention of diabetes is an important mandate in public health, it is also important to help those who are currently living with the disease.

It is estimated that 15-40% of individuals with diabetes have comorbid depression (Anderson, Freedland, Clouse, & Lustman, 2001; Chiu, Wray, Beverly, & Dominic, 2010; Li, Ford, Strine, & Mokdad, 2008; Lin et al., 2008). Depression and depressive symptomatology have been associated with many crucial factors in diabetes management, such as unhealthy behaviors (Chiu, et al., 2010; Gonzalez et al., 2007; Lin et al., 2004), weight control (Faulconbridge et al., 2012; Ludman et al., 2010), and lower cognitive function (Rapp et al., 2011; Snoek et al., 2011). Nonetheless, the extent to which changes in depressive symptoms may relate to changes in weight, behaviors, and cognition has not been well examined. If improvements in depression are associated with preferable weight, behavioral and cognitive trajectories in adults with diabetes, perhaps proactively and optimally treating depression in diabetes patients could ultimately reduce the complications attendant to poor weight control, exercise behavior or cognitive functions.

To date, only a handful of studies have attempted to investigate how changes in depressive symptomatology influence diabetes-management-related factors and provided information suggesting that improvement in depression over five years was associated with clinically significant weight loss (Ludman, et al., 2010). Yet, the existing study was limited by using concurrent longitudinal data from only one health care organization in the U.S. Thus, how change in depressive symptoms may prospectively affect weight and other diabetes management factors, such as health behaviors and cognitive function, in general middle-aged and older adults with diabetes in Asian countries remains uncertain.
The aims of the present study were to assess whether the change scores of depressive symptoms over seven years in general middle-aged and older adults with diabetes in Taiwan are associated with overlapping and subsequent BMI, exercise, and cognitive function trajectories. Specifically, we compared a) patients with persistently low depressive symptoms with those whose depressive symptoms increased (at least 5 points on CES-D) over 7 years from 1996 to 2003 and b) patients with persistently high depressive symptoms with those whose symptoms decreased (at least 5 points on CES-D) from 1996 to 2003 on their levels of and rates of change in weight, exercise, and cognitive function during 1999, 2003 and 2007. Potential gender differences were also evaluated in the present study.

Methods

Data and Sample

Our data was drawn from the 1996-2007 Survey of Health and Living Status of the Elderly in Taiwan (a.k.a., Taiwan Longitudinal Study of Aging, TLSA). Full details regarding the recruitment procedures and characteristics of participants in the TLSA has been described previously (citation). Briefly, it is an on-going nationally representative survey tracing longitudinal changes in health, behavioral, and social well-being of middle-aged and older adults in Taiwan as of 1989. In 1996, reinterviews were completed with 2,669 of the 3,002 survivors from the 1989 survey (response rate=88.9%), and added a nationally representative sample of 2,462 individuals born in 1930-1945 to fill the younger part of the respondents aged between 51-66. As a result, there were 5,131 adults aged 51 and above, representative of the entire Taiwanese population born in 1945 or earlier, interviewed in 1996.

Of the 5,131 adults aged 51 and older in the 1996 survey, there were 581 (11.3%) self-reported physician-diagnosed diabetes patients, and 532 returned valid assessment on
depressive symptoms, measured by Center for Epidemiologic Studies Depression Scale (CES-D). Among the 532 participants, 292 (55%) of them also had depressive symptom measured in 2003. Given that the focus in this study was to examine changes in depressive symptoms in diabetes patients, our sample was restricted to members of diabetes participants who completed CES-D scale on both 1996 and 2003 (N=292). Those who failed to return valid scores on depressive symptoms in the 2003 follow-up survey were not significantly different from those who did on most of the study variables; the exceptions were that the non-respondents were more often male and reported more early complications, as well as lower exercise and perceived control.

**Measures**

The 10-item version of the Center for Epidemiologic Studies Depression Scale (CES-D) was used to assess depressive symptoms in 1996 and 2003. This short version of the CES-D has been widely used in epidemiological research and has demonstrated validity and reliability for use among older adults and Asian populations (Andresen, Malmgren, Carter, & Patrick, 1994; Boey, 1999; Hertzog, Van Alstine, Usala, Jultsch, & Dixon, 1990). Participants indicated the frequency of experiencing each symptom (e.g., feel lonely, sad, not get going, happy, etc.) during the past week. Each item was rated on a four-point scale (scored 0-3) indicating having the symptoms 0, 1, 2-3, or more than 4 days in a week. Responses were reverse scored when necessary such that higher scores represent greater levels of depressive symptomatology. A summary depressive symptom score ranging from 0 to 30 was produced by summing the answers across the ten items. A score of at least 10 of a possible 30 points has been recommended as an optimal cutoff for major depression (Andresen, et al., 1994). Internal consistency and reliability in 1996 and 2003 were .81 and .?, respectively in this sample.
Cognitive function was based on nine-item Short Portable Mental Status Questionnaire (SPMSQ) (Pfeiffer, 1975) and the modified Rey Auditory Verbal Learning Test (m-RAVLT) (Andersson et al., 2006; Schoenberg et al., 2006; Tierney et al., 1994). The nine-item SPMSQ was adequate to assess general cognitive function in older adults (Purser, Fillenbaum, Pieper, & Wallace, 2005). It asked questions including: where are you located now; what is your home address; what is the date of today; what day is today; how old are you; what is your mother’s maiden name; who is the current president; who is the last president, and count backwards from 20 by 3 a total of four times. Each item scored one point, with the scores ranging from 0 to 9. According to Purser’s nine-item criterion, a score of 6-9 was intact cognition. The modified Rey Auditory Verbal Learning Test was used consistently in 1996, 1999, 2003, and 2007 assessing short-term verbal memory. 10 unrelated nouns were read aloud, and then the participant immediately recalls as many words as possible. Scoring is based on total correct words participant can recall (ranges 0-10).

Body Mass Index (BMI) was calculated as weight (kg) divided by height in meters squared (m²). Height and weight were self-reported at each wave in 1999, 2003, and 2007.

Participants in the survey were also asked if they have regular exercise habit. Answers were 0 for no regular exercise, 1 for less than two per week, 2 for 3-5 times a week, 3 for 6 or 7 days a week.

A set of covariates, suggested by literature indicating association with depression among individuals with diabetes (Katon et al., 2004), including demographic variables (age, gender, race/ethnicity, education), behavioral (smoking and drinking status), and clinical variables (years with diabetes, number of comorbidity, disability, using hypnotics or sedatives,) were examined.

Statistical Analysis

We stratified the sample on individual’s CESD score at baseline, forming two groups, those with a CESD score of at least 10 (probable major depression) at baseline and those with
a CESD score of less than 10 (no depression) at baseline. Within these two groups, those who had a substantial change in their level of depression symptoms between 1996 and 2003 were compared to those who did not have a substantial change. Substantial change was defined as a change of at least 5 points on the CESD (Boey, 1999). Specifically, a decrease of at least 5 points for the group with depression at baseline (improving depression symptoms) and an increase of at least 5 points for the group without depression at baseline (worsening depression symptoms). All other individuals in the group with depression at baseline were said to have persistently high depression symptoms, and all other individuals in the group without depression at baseline were said to have persistently low depression symptoms. Thus, in the group with a CESD score of less than 10 at baseline, those with worsening depression symptoms were compared to those with persistently low depression symptoms, and in the group with a CESD score of 10 or greater at baseline, those with improving depression symptoms were compared to those with persistently high depression symptoms.

Within each group (probable major depression at baseline and no major depression at baseline), we conducted bivariate analyses to compare the demographic, behavioral and clinical characteristics of the substantially changed or unchanged groups using chi-square analyses and t tests for categorical and continuous covariates, respectively. To examine bivariate relationships between baseline cognitive function, BMI, exercise and the covariates, Pearson correlation coefficients and t tests were used for the continuous and dichotomous covariates, respectively.

Linear mixed models were used to examine if diabetes patients who had significantly changes in depressive symptoms during 1996 and 2003 were associated with different levels and annual rates of change in concurrent (1996-2003) and prospective (1999-2007) trajectories in memory function, BMI, and exercise, compared with participants who has persistent low or high depressive symptoms over time. We used year after 1996 as the measure of time in these models, and controlled for covariates that have been shown to have
relationships to depressive symptom change, including demographic variables (age, gender, race/ethnicity, education); diabetes characteristics (years with diabetes); and health variables (number of comorbidity, disability, using hypnotics or sedatives, smoking and drinking status). A significant group-by-year interaction is interpreted as having significantly different trends in weight over time depending upon group status.

Although not every participant has complete data till 2007, the use of multilevel regression models enabled us to analyze the unbalanced data, i.e., different number of follow-up occasions or different follow-up times. All analyses were performed using SAS 9.1.3.

Results

Sample characteristics and association with depressive symptoms scores

Table 1 shows all covariates we examined in the bivariate analyses investigating their relationships to the depression groups. All the covariates, except for age, ethnicity and education, were associated with depression groups, and thus were included in the subsequent mixed models.

Memory, BMI, and exercise trajectories in adults with low symptoms of depression at baseline

Those who worsened over time in comparison to those with persistently low symptoms at both time points did not differ in their pattern of memory function change both concurrently during 1996-2003 and prospectively during 1999-2007. However, there were significantly different overall patterns of change on BMI and exercise behavior over time between those with persistently low depressive symptoms and those with worsening depression symptoms. Individuals with persistent low depression symptoms during 1996-2003 lost 0.09 BMI (kg/m^2) per year during 1999-2007, but those with worsening
depression symptoms had an increase in their BMI by 0.16 (kg/m²) per year (calculated by the main effect of year -0.09 and an interaction term of group*year 0.25). In other words, if an individual with diabetes who are 1.7 meter high and had persistently low depressive symptoms, he/she will lost about 0.3 kg per year; however, if his/her depressive symptoms increased more than 5 points out of the 30 points CES-D scale during 1996-2003, he/she had prospective weight increment of approximately 0.5 kg per year during 1999-2007. In addition, although the groups had almost identical exercise score at baseline (1.48 vs. 1.51) and both had positive rates of change in their exercise, the significant time-by-group interaction indicating those whose symptoms were worsened had much lower increase (0.08-0.06=0.02 points/year) in comparison to those with persistent low symptoms (0.08 points/year) during the 7-year concurrent assessment on exercise. These results were estimated with the covariates, including sex, years with diabetes, number of comorbidity, number of disability, using hypnotics or sedatives, smoking and drinking status, in the models.

Memory, BMI, and exercise trajectories in adults with high symptoms of depression at baseline

Compared to those with persistently high depressive symptoms, individuals with improving depression symptoms over the 7-year period did not have significantly different patterns on BMI or exercise behavior, concurrently or prospectively. However, a significant time-by-group interaction in the memory trajectory indicating that improving depression change pattern was significantly associated with a lower decline in memory function. While those with persistently high depressive symptoms decrease a mean of 0.26 points on m-RAVLT score per year (SD=0.07), those with improving depression symptoms only decreased 0.09 (-0.26+0.17=-0.09) points per year. All of the results above has controlled for covariates including sex, years with diabetes, number of comorbidity, number of disability, using hypnotics or sedatives, smoking and drinking status.
Discussion

Depressive symptoms in older adults are associated with both poor cognitive function and subsequent cognitive decline (Jorm, 2000; Yaffe et al., 2004). Literature also indicated that depression was associated with risk of mild cognitive impairment (Barnes, Alexopoulos, Lopez, Williamson, & Yaffe, 2006) and Alzheimer’s (Ownby, Crocco, Acevedo, John, & Loewenstein, 2006; Wilson, Mendes de Leon, Bennett, Bienias, & Evans, 2004). However, more recent prospective epidemiological study indicated that depressive symptoms are cross-sectionally associated with cognitive impairment but not subsequent cognitive decline (Ganguli, Du, Dodge, Ratcliff, & Chang, 2006). Our findings are correspondent to the later one. In addition, Existing literature indicating mild (or greater) symptoms of depression at baseline did not prevent overweight/obese individuals with type 2 diabetes from achieving significant weight loss(Faulconbridge, et al., 2012). A very significant U-shaped (quadratic) association between BMI (BMI2) and depression (de Wit, van Straten, van Herten, Penninx, & Cuijpers, 2009). In dementia, the presence of depression corresponds to accelerated cognitive decline beyond gender and level of education, suggesting a unique influence of depression on the rate of cognitive decline in dementia (Rapp, et al., 2011).

Both major depression (Lin, et al., 2004) or low levels of depressive symptomology (Gonzalez, et al., 2007) are associates with no adherence to important aspects of diabetes self-care, such as exercise, diet, and medication adherence.

Weight change pattern in adults with diabetes may be strongly associated with depressive symptoms. Our study investigating depressive symptom changes and weight trajectories support existing literature indicating that there were different patterns of weight change in adults diagnosed with diabetes (Feldstein, Nichols, Smith, Rosales, & Perrin, 2008), and extends that for those who have high depressive symptoms at baseline, whether improved
their depressive symptoms or not, weight changes over time, both concurrently or prospectively, were hard to be detected. However, for those who have low depressive symptoms at baseline, their weight change over time hinges on how their depressive symptoms changed: individuals with consistently low level of depressive symptoms over time had a mean weight loss trajectory that is clinically significant, but individuals who increased their depressive symptoms are associated with increased rated of change in their weight. In addition, literature indicating disparities in the prevalence of depression and anxiety exist among people with different BMI levels (Zhao et al., 2009). Individuals with comorbid depression tend to have poorer glycemic control or more debilitating complications of their diabetes (Lin et al., 2010). Depressive symptoms result in an increase in abdominal obesity independent of overall obesity (Vogelzangs et al., 2008).
REFERENCE


Test in selected clinical samples. *Archives of Clinical Neuropsychology, 21*(7), 693-703.


<table>
<thead>
<tr>
<th></th>
<th>Baseline CESD&lt;10(n=216)</th>
<th>Baseline CESD&gt;=10(n=76)</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total sample(N=292)</td>
<td>Persistently low depression symptoms(n=159)</td>
<td>Worsening depression symptoms(n=57)</td>
</tr>
<tr>
<td>Age(y),M(SD)</td>
<td>65.09 (7.75)</td>
<td>64.43 (7.71)</td>
<td>66.00 (8.04)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%Women</td>
<td>58.90</td>
<td>50.94</td>
<td>61.40</td>
</tr>
<tr>
<td>Education(y),M(SD)</td>
<td>4.41(4.58)</td>
<td>5.25 (4.45)</td>
<td>4.63(5.17)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%Fuchien</td>
<td>66.44</td>
<td>66.04</td>
<td>64.91</td>
</tr>
<tr>
<td>%Mainlander</td>
<td>16.78</td>
<td>18.24</td>
<td>15.79</td>
</tr>
<tr>
<td>%Hakka and others</td>
<td>16.78</td>
<td>15.72</td>
<td>19.30</td>
</tr>
<tr>
<td>Years with diabetes, M(SD)</td>
<td>6.58 (6.35)</td>
<td>6.06 (6.34)</td>
<td>8.21 (7.10)</td>
</tr>
<tr>
<td>#of comorbidity, M(SD)</td>
<td>2.16(1.31)</td>
<td>1.96(1.14)</td>
<td>2.04(1.13)</td>
</tr>
<tr>
<td>#of disability, M(SD)</td>
<td>1.63(2.65)</td>
<td>1.09(1.99)</td>
<td>1.37(2.56)</td>
</tr>
<tr>
<td>%Using hypnotics/ sedatives</td>
<td>10.27</td>
<td>5.03</td>
<td>8.77</td>
</tr>
<tr>
<td>%current smoker</td>
<td>19.86</td>
<td>21.38</td>
<td>21.05</td>
</tr>
<tr>
<td>%current drinker</td>
<td>17.81</td>
<td>22.01</td>
<td>17.54</td>
</tr>
</tbody>
</table>

*p<.05
### Table 2. Fixed Effect Coefficients from Mixed Models of Changes in Exercise, BMI, and Cognitive Score Over Time

<table>
<thead>
<tr>
<th>Baseline CESD ≥ 10 (n=76)</th>
<th>Recall(m-RAVLT)</th>
<th>Exercise</th>
<th>Recall(m-RAVLT)</th>
<th>BMI</th>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concurrent</td>
<td>Prospective</td>
<td>Concurrent</td>
<td>Prospective</td>
<td>Concurrent</td>
<td>Prospective</td>
</tr>
<tr>
<td>Intercept</td>
<td>4.71(0.25)**</td>
<td>4.84(0.33)*</td>
<td>24.04(0.58)***</td>
<td>1.48(0.15)*</td>
<td>1.51(0.19)*</td>
</tr>
<tr>
<td>Year</td>
<td>-0.15(0.04)*</td>
<td>-0.15(0.03)*</td>
<td>-0.09(0.04) *</td>
<td>0.08(0.02)*</td>
<td>0.04(0.02)*</td>
</tr>
<tr>
<td>I/W</td>
<td>-0.21(0.31)</td>
<td>-0.36(0.49)</td>
<td>-1.00(1.01)</td>
<td>-0.07(0.21)</td>
<td>-0.11(0.28)</td>
</tr>
<tr>
<td>Year* I/W</td>
<td>0.01(0.05)</td>
<td>0.048(0.06)</td>
<td>0.25(0.12)*</td>
<td>-0.06(0.04)</td>
<td>-0.06(0.04)</td>
</tr>
</tbody>
</table>

Notes: All the coefficients were controlled for…….. Values in parentheses were standard deviations

***p<0.001; **p<0.01; *p<0.05; ^p<0.1; Concurrent:1996-2003 trajectory; Prospective:1996-2003 trajectory; I/W: improving/ worsening
Figure 1. Exercise Score after 1996 by Depressive Symptom Group

Figure 2. BMI Change after 1996 by Depressive Symptom Group

Figure 3. Memory function (m-RAVLT) after 1996 by Depressive Symptom Group