The influence of depression and anxiety on outcomes after an intervention for prediabetes

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ABSTRACT

Objectives: To conduct initial analyses and examine ways in which depression and anxiety are associated with outcomes after participation in the Healthy Living Course (HLC), an early-intervention diabetes prevention program for adults with prediabetes.

Design: Randomised controlled study using pre-intervention and postintervention measures to examine relationships between depression, anxiety and diabetes-related program outcomes.

Participants and setting: 185 adults from urban and rural Victoria with prediabetes who had completed the HLC program and for whom postintervention measure data were available. Data were collected between 15 June 2006 and 15 June 2008.

Main outcome measures: Baseline and postintervention scores on mood (anxiety, depression), biochemical (fasting plasma glucose, oral glucose tolerance), anthropometric (body mass index [BMI], waist circumference), cognitive (self-efficacy, diabetes knowledge) and behavioural (healthy eating, physical activity) measures; correlations between these measures.

Results: The intervention alleviated depression, and improved eating patterns and scores on cognitive, anthropometric and biochemical measures. Cultural group and sex did not influence most results. Baseline mood was not associated with anthropometric or biochemical outcomes; however, more positive baseline mood factors were associated with activity changes, and with greater subsequent activity rates, self-efficacy and diabetes knowledge. In turn, baseline self-efficacy was associated with postintervention healthy eating. Changes towards healthier eating correlated with anthropometric and biochemical changes, while baseline cognitive measures were also associated with physiological outcomes. As expected, reductions in BMI and waist circumference were related to biochemical changes.

Conclusion: Our findings highlight the importance of assessing mood factors in prediabetes, and the need to develop theoretical models of change mechanisms for mood in health outcomes.

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Prevention is important in reducing the burden associated with type 2 diabetes.[1-3] Adherence to lifestyle interventions reduces the risk of prediabetes progressing to diabetes,[4-6] and modifying risk factors (eg, diet and exercise) is key to successful intervention.

Patients' knowledge of the necessary lifestyle modifications and their self-confidence in their ability to change are linked to improved glycaemic control, and are important predictors of behaviour change.[7-10] However, depression is associated with poorer attendance at intervention programs.[11] Additionally, numerous studies indicate an increased likelihood of depression and anxiety disorders in both people with prediabetes and those with type 2 diabetes,[12-15] although causal relations between diabetes, depression and anxiety are complex.[16] Nonetheless, the influence of negative mood on complications and difficulties in maintaining self-care regimens has been established consistently,[17-19] although few studies have focused on prediabetes, and links between mood problems and diabetes-related health outcomes may be mediated by other factors. Supporting a link between progression to type 2 diabetes and depression, a recent study found that the prevalence of depression was higher in people with diabetes than in those with normal glucose metabolism (NGM) and higher in women with impaired glucose tolerance than women with NGM.[20] Previous data from our own research have indicated significant associations between anxiety and depression and lower levels of pretreatment healthy eating, self-efficacy and knowledge about diabetes.[21] However, little research has examined mechanisms by which mood problems influence outcomes after intervention for prediabetes.

We aimed to undertake initial analysis of data from patients who completed an early-intervention diabetes prevention program for adults with prediabetes, to garner support for a preliminary model of the association between mood and outcomes. While depression has been associated with dropout from a similar intervention,[11] no studies have reported whether interventions of this kind ameliorate negative mood states. Furthermore, there has been little theoretical development with respect to understanding how mood might influence biochemical, anthropometric, psychological and behavioural outcomes. Having established that mood, anthropometric, biochemical, cognitive and behavioural measures improve with treatment, we expected baseline mood levels to be associated with post-treatment psychological and behavioural measures, and changes in these psychological and behavioural factors to be associated with outcome anthropometric and biochemical measures.

METHODS

Participants were adults who satisfied the clinical diagnostic criteria for prediabetes and who had completed the Healthy Living Course (HLC) diabetes prevention program and pre-intervention assessments of depression, anxiety, waist circumference, body mass index (BMI), and postintervention measures of cognitive and behavioural variables. Our sample included specifically targeted participants from Chinese backgrounds, because our focus on the role of negative mood states across people with prediabetes required a wide range of anthropometric characteristics. Participants were recruited from two metropolitan regions and one rural region in Victoria through general practitioner referral, opportunistic community screening and self-referral (details reported previously[21]).

Prediabetes was diagnosed by a 75 g oral glucose tolerance test and by applying World Health Organization diagnostic criteria for prediabetes.[2] At baseline, participants displayed impaired fasting glycaemia (fasting plasma glucose level [FPG], 6.1–7.0 mmol/L) and/or impaired glucose tolerance (2-hour plasma glucose level [2hrPG], 7.8–11.0 mmol/L after a 75 g glucose tolerance test), with both FPG and 2hrPG below those in the diabetic range (FPG, < 7.0 mmol/L; 2hrPG, < 11.1 mmol/L).

Measures

- ***Mood:*** depression and anxiety were assessed by the shortened version of the Depression Anxiety Stress Scales, which correlates with convergent indicators[22,23] across a range of demographic variables,[23,24] and demonstrated adequate internal consistency in this sample (Cronbach's α for depression, 0.89; Cronbach's α for anxiety, 0.78).
- ***Anthropometric and biochemical indicators:*** these were reported by GPs and included BMI, waist circumference, FPG and 2hrPG.
- ***Cognitive variables:*** the Diabetes Self-efficacy Scale[21] was used to assess the degree to which participants were confident they could maintain healthy eating and exercise patterns (Cronbach's α in this sample, 0.93). The Diabetes Knowledge Scale[21] was used to assess participants' understanding of risk factors, lifestyle factors and potential consequences of type 2 diabetes (Cronbach's α, 0.76).
- ***Behavioural variables:*** an adaptation of the International Physical Activity Questionnaire[25] estimated the number of hours of activity per week. Reliability and validity data for this scale across 12 countries are available.[25-27] The Food Choices Questionnaire,[21] based on the *Dietary guidelines for Australian adults*,[28] was used to assess the degree to which participants make healthy food choices, and exhibited test–retest reliability of 0.68 and a Cronbach's α of 0.67.

Procedure

Ethics approval was obtained from the human research ethics committees of the Department of Human Services Victoria, the Royal Australian College of General Practitioners and Southern Health. Data collection occurred between 15 June 2006 and 15 June 2008. After being diagnosed with prediabetes, participants completed pre-test questionnaires (mood, cognitive and behavioural variables), attended their GP for pre-test anthropometric measurements and were referred to the HLC (a 6-month, group-administered diabetes prevention program based on an individualised intervention[5]). The HLC aims to promote lifestyle changes, increase motivation, and reduce the risk of progression to type 2 diabetes. To ensure standardised delivery, facilitators attended 3-day training on module delivery, assessment, motivational techniques and group processes. In the last HLC session, participants completed postintervention cognitive, mood and behavioural questionnaires and were asked to return to their GP for follow-up anthropometric and biochemical assessments.

Statistical analysis

Repeated-measures 2 (sex) by 2 (culture) analysis of variance was used to assess differences between pre-intervention and postintervention levels of depression, anxiety, and anthropometric, biochemical, cognitive and behavioural variables among participants who completed the HLC. Given the known differences between Chinese and non-Chinese cohorts on metabolic syndrome risk factors,[21] the culture variable was based on this distinction.

Pearson correlations were used to examine associations between baseline and postintervention non-adjusted change scores in eating habits, anthropometric and biochemical measures.[29] Partial correlations were used to assess associations of baseline measures of mood, behaviour and cognition with follow-up anthropometric, biochemical and psychological measures, controlling for baseline scores on those measures.[30] This allowed examination of associations between baseline variables and follow-up outcomes that were not related to respective baseline scores.

RESULTS

There were 185 participants (69 men, 116 women), representing 58% of participants

1 Mean mood, anthropometric and biochemical indicators for participants at baseline, and mean change in these indicators after the intervention

Measure	No. of participants	Baseline mean (SD)	Change from baseline mean	95% CI of the change	F	Partial η^2
Mood						
Depression	162	6.38 (7.36)	–0.95	–1.94 to 0.03	3.75*	23
Anxiety	163	4.96 (6.18)	–0.27	–1.09 to 0.55	0.77	0.005
Biochemical indicators						
Fasting plasma glucose level	120	5.90 (0.83)	–0.20	–0.37 to –0.03	5.34*	43
2-hour plasma glucose level	107	8.53 (1.38)	–0.64	–1.09 to –0.20	8.39†	0.073
Anthropometric measures						
Body mass index	108	29.66 (5.47)	–1.26	–1.61 to –0.90	48.29‡	311
Waist circumference	87	94.44 (12.67)	–2.47	–3.96 to –0.98	10.87†	0.112
Cognitive measures						
Self-efficacy	159	7.39 (1.38)	0.21	0 to 0.46	4.67*	29
Diabetes knowledge	141	8.58 (2.82)	1.69	1.29 to 2.09	69.93‡	0.333
Behaviour						
Healthy eating	182	3.15 (0.33)	0.19	0.15 to 0.22	105.90‡	369
Activity (hours)	126	6.72 (5.92)	0.71	–0.45 to 1.92	1.37	0.01

* $P < 0.05$. † $P < 0.01$. ‡ $P < 0.001$. ◆

2 Pearson correlations between baseline depression and anxiety and change scores in cognitive, behavioural, anthropometric and biochemical measures, and between change indices

			Change in:						
Change in:	Baseline depression	Baseline anxiety	Diabetes knowledge	Activity	Healthy eating	BMI	Waist circumference	FPG	2hrPG
Self-efficacy	–0.03	0	–0.03	0.12	0	–0.02	0.05	0.01	0.12
Diabetes knowledge	0.01	0.12	—	–0.05	0.14*	–0.03	0.20*	0.01	–0.04
Activity	–0.25†	–0.24†		—	0.01	0.08	0	0.04	0.11
Healthy eating	0.06	0.09		—	—	0.19‡	0.26‡	0.27†	0.24‡
BMI	–0.09	–0.04		—	—	—	0.47§	0	0.29†
Waist circumference	–0.08	0.02		—	—	—	—	0.18‡	0.30†
FPG	0.13	0.02		—	—	—	—	—	–0.14
2hrPG	0.01	–0.15		—	—	—	—	—	—

Change = postintervention score minus baseline score. BMI = body mass index. FPG = fasting plasma glucose level. 2hrPG = 2-hour plasma glucose level.
* $P < 0.10$. † $P < 0.01$. ‡ $P < 0.05$. § $P < 0.001$. Sample sizes for correlations vary. ◆

who were referred and met inclusion criteria.[21] Ages of participants ranged from 28 to 81 years (mean, 61.96 years; SD, 10.17 years). The sample was predominantly Anglo-Australian, but included 28 specifically targeted participants from Chinese backgrounds.

At the time of this analysis, 120 participants had completed postintervention 2hrPG and/or FPG tests. There were no significant differences between those who completed postintervention glucose tolerance tests and those who did not on pre-intervention measures of glucose metabolism, BMI, mood, cognitive or healthy eating variables, or on postintervention measures of psychosocial variables. However, those who had not completed the second glucose tolerance test had significantly larger waist circumferences at baseline ($F_{1,153} = 5.31$; $P < 0.05$) and were less active at pre-intervention ($F_{1,150} = 4.09$; $P < 0.05$) than the remainder.

Numbers of participants for whom data were available on psychosocial variables varied between 141 and 182 as not all participants completed all scales. For the anthropometric and biochemical variables, numbers for whom data were available were smaller (87–120) as only 120 completed the fasting glucose test, and GPs did not consistently report follow-up waist circumferences and weights.

Box 1 shows baseline and postintervention scores on mood, biochemical, anthropometric, cognitive and behavioural variables for the total sample. Depression (but not anxiety) decreased significantly over the intervention period. There were significant improvements in 2hrPG and FPG, and significant decreases in BMI and waist circumference. Healthy eating, diabetes self-efficacy and diabetes-related knowledge all improved significantly, but activity rates did not.

When cultural group and sex were included as between-group variables, results generally remained consistent. There were no significant interactions with sex or cultural group for any mood, biochemical, anthropometric or cognitive variables. For healthy eating, there was a significant time by sex interaction ($F_{1,175} = 11.98$; $P < 0.01$) and a significant time by sex by cultural group interaction ($F_{1,175} = 5.25$; $P < 0.05$). Despite lower baseline levels of healthy eating among men, particularly Chinese men, all subgroups reported similarly healthy eating patterns after the intervention. Overall, activity change was not significant, but men increased their activity significantly more than women ($F_{1,12} = 4.41$; $P < 0.05$).

Pearson correlations (Box 2) and partial correlations (Box 3) indicated that neither baseline depression nor anxiety were associated with anthropometric or biochemical changes or outcomes when controlling for baseline outcomes. However, partial correlations indicated that more positive initial mood was associated with higher subsequent activity rates and, in the case of depression, greater subsequent self-efficacy and diabetes knowledge when accounting for baseline scores on those variables (Box 3). Pearson correlations indicated significant changes between baseline depression and activity change scores (Box 2). In turn, baseline self-efficacy exhibited a significant partial correlation with healthier eating and reduced BMI after controlling for related baseline measures (Box 3). Similarly, baseline diabetes knowledge was associated with postintervention FPG after controlling for baseline FPG (Box 3). Change towards healthier eating correlated significantly with changes in anthropometric and blood glucose measures (Box 2). As expected, there were significant Pearson correlations between pre–post change indices for 2hrPG and both BMI and waist circumference, and between pre–post change indices for FPG and waist circumference (Box 2).

DISCUSSION

Despite there being relatively few data on prediabetes, links between psychological distress in people with prediabetes and progression to type 2 diabetes have found some support, especially in men.[19,20] While depression is associated with poorer outcomes in diabetes,[11,15-17] our study indicates that, rather than depression necessarily having a direct effect on physical outcomes, there is a complex set of interrelationships between mood, psychosocial, lifestyle, anthropometric, and health-related variables in prediabetes. While we found no evidence for high levels of depression or anxiety in our cohort of patients with prediabetes, we found a small but significant improvement in the level of depression after participants completed a diabetes prevention program, consistent for both sex and cultural group. That these findings occurred in a relatively non-depressed sample of volunteers underlines the importance of mood in self-care.

The focus of our article was to examine whether mood was associated with outcomes following intervention, and to develop preliminary notions of how mood

3 Partial correlations of selected baseline and postintervention psychosocial, behavioural, anthropometric and biochemical measures, controlling for corresponding baseline measure

	Baseline					
Postintervention	Depression	Anxiety	Self-efficacy	Diabetes knowledge	Activity	Healthy eating
Self-efficacy	–0.22*	–0.10	—	—	—	—
Diabetes knowledge	–0.20†	–0.14	—	—	—	—
Activity	–0.25*	–0.22†	0.12	0.13	—	—
Healthy eating	–0.13	–0.04	0.26*	0.10	—	—
Body mass index	0.08	0.09	–0.22†	–0.20‡	–0.03	–0.15
Waist circumference	0.05	0.02	–0.09	–0.09	–0.02	–0.02
FPG	–0.14	–0.05	–0.05	–0.23†	0.01	–0.09
2hrPG	0	0.12	0.08	0.03	0.09	–0.19‡

FPG = fasting plasma glucose level. 2hrPG = 2-hour plasma glucose level.
* $P < 0.01$. † $P < 0.05$. ‡ $P < 0.10$. ◆

affects health outcomes. Having established that the intervention decreased participants' scores on prediabetes indicators and depression, we examined the association of baseline mood on outcomes. Baseline depression was not predictive of anthropometric or biochemical changes or outcome levels at 6-month follow-up, but did predict changes in activity and subsequent self-efficacy, diabetes knowledge, and activity after controlling for baseline scores on those measures. Our findings thus suggest that mood may have an impact on people's ability to change activity levels, and later knowledge and confidence to fully engage in necessary behavioural change, even when accounting for initial cognition. These factors are important in protecting individuals with prediabetes from progression to type 2 diabetes. Previous research has also indicated that mood factors may inhibit attendance at diabetes prevention programs.[11] It remains to be seen whether depression or its amelioration affect physical health over longer follow-up periods.

It is likely that there are multiple and complex relationships between negative mood and physical outcomes associated with prediabetes. Our findings provide some provisional support for a model of change whereby baseline psychological factors (mood, self-efficacy) are associated with later diabetes-relevant behavioural (eg, activity levels, healthy eating) and physical outcomes. While baseline cognitive variables predicted subsequent physiological measures, even after controlling for baseline physical status, it is not clear what specific pathways might lead from cognition to improved physiological outcomes. Self-efficacy has previously been associated with self-care in diet, exercise and blood glucose testing, although a range of factors may mediate associations with physical outcomes.[10] In this study, changes towards healthier eating habits correlated significantly with changes in all anthropometric and biochemical measures, although some researchers have questioned the reliability of unadjusted change scores, particularly for measures with high likely levels of measurement error.[30]

Our study has identified important process outcomes that may advance models of change mechanisms. However, our sample size was insufficient for the use of modelling techniques. As additional studies and follow-up data accumulate, we will be able to use more sophisticated analytical techniques to further evaluate these findings. Sampling limitations included possible self-selection of participants, the high drop-out rate, and non-completion of some measures by participants, as well as the possible influence of sex and culture. Sex and cultural factors did not appear to play important roles in our study, but further investigations with larger samples from specific social groups and a broader range of indices of metabolic syndrome may give a more complete picture of the influences on treatment outcome. While selection and drop-out bias may overestimate or underestimate the effects of intervention, our focus in this study was on examining treatment processes among people who completed the intervention. This group is of particular interest in clinical settings, as depression may interfere with behavioural, cognitive and biological processes associated with healthier outcomes. However, from a public health perspective, it is also important to examine factors such as depression that lead to dropping out of, choosing not to enrol in, or not engaging fully with intervention programs.

Overall, our findings support the assessment of mood problems in prediabetes and taking into consideration the effect of even mild mood problems on factors that can influence physical outcomes. Treating depression and anxiety early in lifestyle interventions may improve participation and engagement, thus helping to maximise behavioural and health-related changes in patients with prediabetes. Nonetheless, ongoing research is required to further develop and evaluate theoretical models of change mechanisms in health and mental health outcomes after early intervention for prediabetes.

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COMPETING INTERESTS

None identified.

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