


Research: Educational and Psychological Aspects

Prevalence and correlates of diabetes distress, perceived stress and depressive symptoms among adults with early-onset Type 2 diabetes: cross-sectional survey results from the Danish DD2 study

A. Bo^{1,2} , F. Pouwer^{3,4,5}, L. Juul⁶, S. K. Nicolaisen⁷ and H. T. Maindal^{1,8}

¹Department of Public Health, Aarhus University, Aarhus, Denmark, ²Danish Diabetes Academy, Odense, Denmark, ³Department of Psychology, University of Southern Denmark, Odense, Denmark, ⁴School of Psychology, Deakin University, Geelong, Australia, ⁵Steno Diabetes Center Odense, Odense, Denmark, ⁶Department of Clinical Medicine, Danish Center for Mindfulness, Aarhus University, Aarhus, Denmark, ⁷Department of Clinical Epidemiology, Aarhus University Hospital, Aarhus, Denmark and ⁸Steno Diabetes Centre Copenhagen, Health Promotion, Gentofte, Denmark

Accepted 22 July 2019

Abstract

Aims To establish the prevalence of diabetes distress, perceived stress and depressive symptoms among adults with early-onset Type 2 diabetes, and to examine their association with socio-demographic and clinical characteristics.

Methods A cross-sectional survey was performed among individuals with Type 2 diabetes aged 20–45 years who were included in the Danish nationwide Danish Center for Strategic Research in Type 2 Diabetes cohort between 2010 and 2016. The survey assessed diabetes distress (20-item Problem Areas in Diabetes Scale), perceived stress (10-item Perceived Stress Scale) and depressive symptoms (10-item short form of the Center for Epidemiological Studies Depression Scale Revised), as well as socio-demographic characteristics. Clinical data were collected from national health registers.

Results In total, 216/460 (47%) individuals (48% women) with Type 2 diabetes completed the survey. The median (IQR) age was 42 (38–44) years and the diabetes duration was 5 (3–7) years. In total, 24% of respondents reported high diabetes distress (Problem Areas in Diabetes Scale ≥ 40), 46% reported high perceived stress (Perceived Stress Scale ≥ 18) and 41% reported elevated symptoms of depression (Center for Epidemiological Studies Depression Scale Revised ≥ 10). The prevalence of emotional problems was higher among women than men. Diabetes distress was higher among those prescribed non-insulin glucose-lowering drugs (vs. no glucose-lowering drugs), but was not associated with other clinical or socio-demographic characteristics. High perceived stress was associated with being unemployed and using antidepressant medication, and elevated depressive symptoms were associated with low education level, unemployment, living alone, having a psychiatric disorder and using antidepressant medication.

Conclusion We found a high prevalence of emotional problems among adults with early-onset Type 2 diabetes in Denmark. Health care for this group should focus on both physical health and psychosocial circumstances and should also address general as well as diabetes-specific emotional problems.

Diabet. Med. 00: 1–9 (2019)

Introduction

Type 2 diabetes is increasingly common among younger adults [1], and several studies have documented an adverse clinical risk factor profile and high risk of complications among adults aged under 40–45 years with Type 2 diabetes [1–3]. A few studies have also reported a higher prevalence of emotional problems among younger compared with older

individuals with Type 2 diabetes [4,5]. This may be due to the combined burdens of poor physical health status, the unrelenting demands of diabetes management, and of a range of life-stage specific stressors such as education, working life, family life, parenting and social commitments, which may exacerbate the emotional burden of Type 2 diabetes [6,7].

The emotional burden specifically related to living with Type 2 diabetes is known as ‘diabetes distress’ [8], includes anxiety, guilt and feeling overwhelmed or unsupported in relation to diabetes. Approximately one in three individuals in

Correspondence to: Anne Bo. E-mail: anne.bo@ph.au.dk

What's new?

- Adults with early-onset Type 2 diabetes have an adverse risk factor profile. In Denmark, data on their psychosocial profile are needed to develop adequate health services.
- Almost half of 216 adults aged 20–45 years with Type 2 diabetes reported high levels of perceived stress and depressive symptoms, while a quarter reported high diabetes distress. The prevalence of emotional problems was higher among women and among some groups of lower socio-economic status.
- Health services should be adapted to meet life-stage specific needs in this group and to integrate psychosocial aspects into diabetes care. Gender-specific interventions may be needed.

general populations with Type 2 diabetes report a high diabetes distress level [9], which is associated with higher HbA_{1c}, poor self-care behaviours and lower self-efficacy [10,11], and is found at higher levels among those with complications and those using insulin [10,11]. Depression is up to twice as common in people with than without Type 2 diabetes [12], and is associated with poor diabetes outcomes [13]. Among general populations with Type 2 diabetes, the prevalence of major depressive disorder was found to be 10%, and 17% of people with Type 2 diabetes report elevated depressive symptoms [14]. Perceived stress reflects the emotional burden that occurs when external demands exceed an individual's perceived resources for coping with the demands [15]. Stress may contribute to poor health outcomes in Type 2 diabetes through behavioural and physiological pathways [16].

In Denmark, around 15 000 people aged 20–45 years [17] have Type 2 diabetes (~6% of all those diagnosed with Type 2 diabetes). There are no specific services targeting this group. We recently showed that there is a higher prevalence of risk factors among those diagnosed at a younger age of those with newly diagnosed Type 2 diabetes in Denmark [18]. This calls for greater awareness of the characteristics of adults with early-onset Type 2 diabetes to be able to tailor health services accordingly. The overall objective for this study was therefore to profile adults with early-onset Type 2 diabetes in Denmark in terms of their psychosocial characteristics. We aimed to (i) establish the prevalence of diabetes distress, perceived stress and depressive symptoms, and (ii) examine their associations with socio-demographic and clinical characteristics.

Methods**Design and participants**

A cross-sectional survey study was conducted in a subsample of individuals aged 20–45 years ($n = 460$) in the

Danish nationwide Danish Center for Strategic Research in Type 2 Diabetes (DD2) cohort. This ongoing cohort study has enrolled more than 8000 people aged > 17 years with newly diagnosed Type 2 diabetes from general practice and hospital outpatient clinics since 2010 [19]. Enrolment procedures have been described elsewhere [19,20]. In brief, when general practitioners or hospital physicians diagnose a person with Type 2 diabetes as part of routine clinical practice, they subsequently invite this person to participate in the DD2 cohort. After informed consent is given, the participants undergo clinical examinations including blood testing. Additional data are collected via linkage with Danish national registers [20]. By November 2016, there were 7053 participants with linked register information in the DD2 database. Among these, 482 individuals were aged ≤ 45 years, of whom 22 could not be contacted due to an invalid or withheld address. We sent out a postal letter with information and a link to the online questionnaire (using SurveyXact) to 460 eligible people (the youngest person was 20 years old) in November 2016, followed by a reminder letter including a paper version of the questionnaire. No incentives were offered to participants. A total of 216 (47%) individuals completed the survey (paper survey, $n = 74$; online survey, $n = 142$).

Survey measures

Diabetes distress was assessed by the 20-item Problem Areas in Diabetes Scale (PAID-20) [8]. Participants rated how much of a problem (0 = not a problem to 4 = serious problem) they currently considered each of the problem areas to be. The scale ranges from 0–100, and a score of 40 or higher is generally used to indicate a high level of diabetes distress [9]. Two questions developed by Hansen *et al.* [21] to fit the format of the PAID questions assessed work-related diabetes distress. Individuals rated how much of a problem they currently considered 'worrying about your ability to do your job due to your diabetes' and 'often feeling exhausted by simultaneously reconciling work and diabetes' to be. We reported the totals responding 'Serious' or 'Somewhat serious problem'. Perceived stress was assessed by the 10-item Perceived Stress Scale (PSS) [15]. Individuals rated how often (0 = never to 4 = very often) during the past month they had experienced specific symptoms of stress. The scale ranges from 0 to 40, and we considered a score of ≥ 18 as indicating a 'high stress level'. This cut-off point corresponds to the upper quintile of PSS levels in the Danish population and is associated with higher mortality [22]. Depressive symptoms were assessed using the 10-item short form of the Center for Epidemiological Studies Depression Scale Revised (CESD-R-10) [23]. Individuals rated how often during the past week (0 = less than 1 day, 1 = 1–2 days, 2 = 3–4 days, and 3 = 5–7 days) they had experienced specific symptoms. The scale ranges from 0 to 30, and a score ≥ 10 denotes elevated depressive symptoms [23]. We only calculated a total score

for those individuals who had no items missing from the PAID ($n = 200$), PSS ($n = 208$) and CESD-R-10 ($n = 202$) scales. Information about social status and diabetes care provider was also assessed in the survey.

Clinical characteristics and medication use

Information regarding the burden of co-morbidity (Charlson's Co-morbidity Index) and diabetes complications was collected for the past 10 years from the Danish National Patient Registry. Psychiatric diagnosis data were collected from the same register, but only for the past 3 years, in order to include conditions which may affect the current psychosocial status of respondents. Medication use was obtained from the Danish National Prescription Registry.

Statistical analysis

We calculated proportions for categorical variables and mean with SD or median with interquartile range (IQR) for continuous variables. We examined background characteristics and prevalence of emotional problems for all respondents, and separately for men and women and for those aged 20–40 years. We used Spearman rank correlation coefficients (ρ) to estimate the pairwise correlations between the PAID, PSS and CESD-R-10 scores. Linear regression models calculated unstandardized beta coefficients adjusted for age and sex to examine associations between each of the predictor variables and the three self-reported emotional outcomes. Using Poisson regression, we conducted a non-response analysis comparing clinical characteristics between respondents and non-respondents when adjusting for age and sex. Statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Ethics

The ethical considerations of the DD2 study have been published previously [19]. For the survey study, written information was provided to participants, along with a statement about voluntary participation. The study was approved by the Danish Data Protection Agency (number 2015-57-0002). The Committees on Health Research Ethics confirmed that the present study does not need ethical approval according to Danish law (journal number 1-10-72-189-16).

Results

Background characteristics

Almost half of the 216 respondents were women (48%), the median (IQR) age was 42 (38–44) years, and the median (IQR) Type 2 diabetes duration was 5 (3–7) years (Table 1).

With regard to diabetes complications, 10% had a hospital diagnosis of retinopathy and 4% had macrovascular complications. Among respondents, 24% did not receive any glucose-lowering drugs, 16% used insulin, and the remaining 60% only used oral glucose-lowering drugs. Characteristics for the age and sex subgroups are presented in Table 1. Non-response analysis showed slightly more women than men among respondents than non-respondents (48 vs. 44%), but age and clinical characteristics were similar in the two groups (data not shown).

Prevalence of emotional problems among adults with early-onset Type 2 diabetes

Diabetes distress correlated moderately with perceived stress ($\rho = 0.36$, $P < 0.001$) and with depressive symptoms ($\rho = 0.32$, $P < 0.001$). Perceived stress correlated highly with depressive symptoms ($\rho = 0.80$, $P < 0.001$). Among respondents, 24% reported a high level of diabetes distress (PAID score ≥ 40), 46% reported a high perceived stress level (PSS score ≥ 18) and 41% reported elevated symptoms of depression (CESD-R-10 score ≥ 10) (Table 2). For those aged 20–40 years, the scores were 24, 54 and 48%, respectively. Among all 216 respondents, 16% used antidepressant medication and 8% had a psychiatric diagnosis (Table 2). The prevalence of all types of emotional problems was considerably higher among women than men (Table 2).

Socio-demographic correlates of emotional problems

Analyses adjusted for sex and age showed that diabetes distress levels were similar across socio-demographic groups (Table 3). The perceived stress level was higher among people who were unemployed by 3.88 (95% CI 1.46 to 6.31) (vs. employed individuals). The level of depressive symptoms was lower among those of medium [-3.67 (95% CI -6.54 to -0.81)] and high education level [-3.42 (95% CI -6.74 to -0.11)] compared with those of low education level. Furthermore, levels of depressive symptoms were higher by 5.69 (95% CI 3.32 to 8.06) among unemployed individuals and among those who lived alone by 3.73 (95% CI 1.63 to 5.83). Perceived stress and depressive symptoms were lower among older persons by -0.21 per year (95% CI -0.40 to -0.01) and -0.32 per year (95% CI -0.52 to -0.12), respectively (Table 3).

Clinical correlates of emotional problems

Diabetes distress was higher among those prescribed non-insulin glucose-lowering drugs compared with those not using glucose-lowering drugs by 6.81 (95% CI 0.33 to 13.29). Otherwise, emotional problems were not associated with clinical characteristics (Table 3).

Table 1 Socio-demographic and clinical characteristics of 216 adults aged 20–45 years with Type 2 diabetes and results for subgroups (men, women and respondents aged 20–40 years)

	Total 20–45 years N = 216		Men 20–45 years N = 113		Women 20–45 years N = 103		Both sexes 20–40 years N = 73	
	n/N	%	n/N	%	n/N	%	n/N	%
Socio-demographic characteristics								
Age (years), median (IQR)	42.0 (38.2 to 44.4)		42.5 (39.1 to 44.5)		41.6 (37.2 to 44.3)		36.4 (32.2 to 38.2)	
20–35 years	28/216	13.0	12/113	10.6	16/103	15.5	28/73	23.3
36–40 years	45/216	20.0	23/113	20.4	22/103	21.4	45/73	61.6
41–45 years	143/216	67.0	78/113	69.0	65/103	63.1	0	0
Women	103/216	47.7	113/113	100	103/103	100	38/73	52.6
Education level								
Low (0–10 years)	29/206	14.1	14/108	13.0	15/98	15.3	11/69	15.9
Medium (11–15 years)	116/206	56.3	64/108	59.3	52/98	53.5	40/69	58.0
High (>15 years)	61/206	29.6	30/108	27.8	31/98	31.6	18/69	26.1
Employed	145/208	69.7	86/109	78.9	59/99	59.6	45/71	63.4
Unemployed	44/208	21.2	14/109	12.8	30/99	30.3	18/71	25.4
Current student	19/208	9.1	9/109	8.3	10/99	10.1	8/71	11.3
Living alone	62/216	28.8	33/113	29.2	29/103	28.4	28/73	38.9
Living with children (own or partners)	106/216	49.1	58/113	51.3	48/103	46.6	27/73	37.0
Danish born	195/208	93.8	102/109	93.6	93/99	93.9	65/70	92.9
Clinical characteristics								
Diabetes duration (years), median (IQR)	5.1 (3.3 to 6.5)		4.6 (3.1 to 6.1)		5.6 (3.6 to 7.6)		5.3 (3.7 to 6.3)	
Previous gestational diabetes, % of women	28/103	27.2			28/103	27.2	10/38	2.6
Family history*	92/213	42.6	49/113	43.5	43/103	41.7	28/73	38.4
Hospital-diagnosed retinopathy	22/216	10.2	13/113	11.5	9/103	8.7	9/73	12.3
Any macrovascular complications	8/216	3.7	5/113	4.4	3/103	2.9	–	–
Charlson Co-morbidity Index								
CCI = 0	182/216	84.3	103/113	91.2	79/103	76.7	63/73	86.3
CCI = 1	22/216	10.2	5/113	4.4	17/103	16.5	7/73	9.6
CCI ≥ 2	12/216	5.6	5/113	4.4	7/103	6.8	3/73	4.1
Treatment health and care services								
No glucose-lowering drugs	51/216	23.6	27/113	23.9	24/103	23.3	22/73	30.1
Non-insulin drugs only	131/216	60.6	70/113	61.9	61/103	59.2	36/73	49.3
Insulin†	34/216	15.7	16/113	14.2	18/103	17.5	15/73	20.5
Anti-hypertensive drugs	66/216	30.6	34/113	30.1	32/103	31.1	16/73	21.9
Lipid-lowering drugs	81/216	37.5	45/113	39.8	36/103	35.0	24/73	32.9
Anti-coagulation drugs	10/216	4.6	7/113	6.2	3/103	2.9	0/73	0
Diabetes care provider								
No consultation	13/206	6.3	7/109	6.4	6/97	6.2	–	–
General practice	142/206	68.9	75/109	68.8	67/97	69.1	–	–
Hospital outpatient clinic	51/206	24.8	27/109	24.8	24/97	24.7	–	–
Has participated in diabetes education	101/210	48.1	50/110	45.5	51/100	51.0	29/70	41.4
Has consulted a dietician	125/210	59.5	63/110	57.3	62/110	62.0	49/71	69.0
Has consulted psychologist or coach	6/209	2.9	3/110	2.7	3/100	3.0	4/71	5.6
Joined a peer support group	15/210	7.1	8/110	7.3	7/100	7.0	7/71	9.9

CCI: Charlson Co-morbidity Index.

*Respondents reported a father, mother or child with diabetes.

†Use of insulin only or insulin in combination with non-insulin glucose-lowering drugs.

– Data omitted out of considerations for anonymity due to cell count < 3.

Specific diabetes-related emotional problems

The most important source of diabetes distress for both men and women was ‘worrying about the future and the possibility of serious complications’ [item 12 (men = 48% and women = 65%)] (Fig. 1). The next most important source was ‘feelings of guilt or anxiety when getting off track with diabetes management’ for women [item 13 (58%)] and ‘feeling burned out by the constant effort needed to manage diabetes’ for men [item 20 (39%)]. In total, 13% reported that they worried about their ability to work due to diabetes

and 10% reported that they felt exhausted by reconciling work and diabetes (Fig. 1).

Discussion

In line with findings from a growing number of international studies [4,5,24], our study identified a high prevalence of emotional problems among adults with early-onset Type 2 diabetes. In our study, levels of stress and depressive symptoms were higher than the diabetes distress level. We found particularly high levels of emotional problems among

Table 2 Prevalence of self-reported emotional problems and register-based information about psychiatric disorder and antidepressant medication use among 216 adults aged 20–45 years with Type 2 diabetes and results for subgroups (men, women and participants aged 20–40 years)

	Total (20–45 years) N = 216 Mean (SD)	Men (20–45 years) N = 113 Mean (SD)	Women (20–45 years) N = 103 Mean (SD)	Men and women (20–40 years) N = 73 Mean (SD)
Diabetes distress (PAID score range 0–100)	26.2 (20.0)	21.5 (17.4)	31.5 (21.4)	27.9 (21.9)
Perceived stress (PSS score range 0–40)	17.2 (7.6)	14.4 (6.8)	20.1 (7.3)	18.5 (7.7)
Depressive symptoms (CESD-R-10 score range 0–30)	9.6 (7.3)	7.7 (6.7)	11.7 (7.4)	11.2 (8.3)

	n/N	%	n/N	%	n/N	%	n/N	%
High diabetes distress level (PAID ≥ 40)	48/200	24.0	18/105	17.1	30/95	31.6	16/66	24.2
High stress level (PSS ≥ 18)	96/208	46.2	32/107	29.9	64/101	63.4	37/69	53.6
Elevated depressive symptoms (CESD-R-10 ≥ 10)	84/202	40.6	30/106	28.3	54/96	56.3	32/67	47.8
Diabetes distress and perceived stress*	31/194	16.0	8/100	8.0	23/94	24.5	13/65	20.0
Diabetes distress and depressive symptoms†	27/188	14.4	6/98	6.1	21/90	23.3	11/63	17.5
Psychiatric disorder‡	17/216	7.9	4/113	3.5	13/103	12.6	8/73	11.3
Current use of antidepressant medication	34/216	15.7	5/113	4.4	29/103	28.2	11/73	15.5

PAID: Problem Areas in Diabetes Scale, 20 items, score range 0–100; PSS: Perceived Stress Scale, 10 items, score range 0–40; CESD-R-10: Short Form Centre for Epidemiologic Studies Depression Scale Revised, 10 items, score range 0–30.

*Respondents reporting PAID ≥ 40 and PSS ≥ 18.

†Respondents with PAID ≥ 40 and CESD-R-10 ≥ 10.

‡Schizophrenia and related disorders, mood disorders, neurotic, stress-related and somatoform disorders, eating and sleep disorders, specific personality disorders.

women, and there was a tendency towards higher levels of emotional problems among those of younger age. There were very few associations between clinical characteristics and levels of emotional problems, but perceived stress and depressive symptoms were found at higher levels in some subgroups of lower social status.

In a previous Australian study [7] of 149 individuals aged 18–39 years with Type 2 diabetes, 63% of survey participants reported high diabetes distress (measured by PAID-5) and 23% reported depressed mood (measured by the WHO-5 Well-Being Index) compared with 24% and 48%, respectively, among the 20–40-year-olds in our study. The choice of survey tools may partly explain the differences, but contextual factors such as higher healthcare costs and job insecurity may also explain the higher diabetes distress among younger Australian adults [6]. Another Australian study among 93 adults with Type 2 diabetes aged < 40 years found a prevalence of high depressive symptoms of 30% (measured by the Patient Health Questionnaire-9). A USA-based study [4] among 506 adults aged 21–45 years with Type 2 diabetes found elevated depressive symptoms (measured by the Center for Epidemiological Studies Depression Scale-20) and high diabetes distress (measured by PAID-17) in approximately 30% of participants compared with 24% and 41%, respectively, among the 20–45-year-olds in our study. Furthermore, 50% of respondents reported a high number of chronic stressors and of negative life events, supporting our finding that stress is a key issue in this group.

With regard to work-related diabetes distress, an earlier Danish study [21] among people with Type 1 diabetes (mean age 47, range 18–70 years) found that 4% and 11% reported

high distress in the two items “worrying about your ability to do your job due to your diabetes” and “often feeling exhausted by simultaneously reconciling work and diabetes” compared with 13% and 11%, respectively, in our study. This may reflect that people with Type 1 diabetes have already adjusted their routines and expectations to working life, due to typically earlier onset, whereas Type 2 diabetes in younger adults often represents a new and unexpected challenge, and often with co-morbid emotional problems.

In 2017, around 10% of Danish adults aged > 25 years used antidepressant medication [25] compared with 16% in our study. The national prevalence of high perceived stress among 25–44-year-olds was 32–36% [26] compared with 46% in our study. Hence, the levels of emotional problems in our study population may be higher than in the background population. A large study from Hong Kong recently found that 37% of hospital bed days before the age of 40 years among people with early-onset Type 2 diabetes (< 40 years) were due to mental illness. This underlines the serious burden of co-morbid mental illness among adults with early-onset Type 2 diabetes.

Unexpectedly, our study showed no association between diabetes distress and diabetes complications, other than co-morbidity or using insulin. This may be due to low statistical power, or because these early complications might have been mild cases eliciting only sub-threshold distress. Further, in Denmark, those with poorer disease status can be offered specialized healthcare support, which may buffer the distress experienced due to diabetes. Those who were not using any glucose-lowering treatment experienced a lower diabetes distress level, which may reflect that they are self-managing

Table 3 Results of linear regression models estimating cross-sectional associations between socio-demographic and clinical characteristics and self-reported emotional problems among 216 adults aged 20–45 years with Type 2 diabetes

	Diabetes distress (PAID, score range 0–100) N = 200		Perceived stress (PSS, score range 0–40) N = 208		Depressive symptoms (CESD-R-10, score range 0–30) N = 202	
	Mean (SD)	Difference (95% CI)	Mean (SD)	Difference (95% CI)	Mean (SD)	Difference (95% CI)
Socio-demographic characteristics						
Women	31.5 (21.4)	Ref	20.1 (7.3)	Ref	11.7 (7.4)	Ref
Men	21.5 (17.4)	-9.68 (-15.1 to -4.21)	14.4 (6.7)	-5.53 (-7.45 to -3.61)	7.7 (6.7)	-3.70 (-5.62 to -1.79)
Age (per year)		-0.23 (-0.79 to 0.33)		-0.21 (-0.40 to -0.01)		-0.32 (-0.52 to -0.12)
20–35 years	34.0 (25.6)	Ref	20.4 (6.9)	Ref	14.8 (9.2)	Ref
36–40 years	24.2 (18.7)	-8.67 (-18.35 to 1.01)	17.3 (8.0)	-2.43 (-5.82 to 0.96)	9.0 (6.9)	-5.55 (-8.90 to -2.20)
41–45 years	25.4 (19.0)	-7.10 (-15.43 to 1.24)	16.5 (7.5)	-3.26 (-6.17 to -0.35)	8.8 (6.6)	-5.75 (-8.62 to -2.87)
Education level						
Low	21.0 (17.8)	Ref	18.9 (8.2)	Ref	12.9 (8.7)	Ref
Medium	26.9 (19.8)	6.96 (-1.42 to 15.34)	17.0 (7.2)	-1.14 (-3.89 to 1.61)	8.9 (7.0)	-3.67 (-6.54 to -0.81)
High	26.0 (19.8)	5.93 (-2.70 to 14.56)	16.8 (8.0)	-1.86 (-5.30 to 1.57)	9.4 (6.8)	-3.42 (-6.74 to -0.11)
Employed						
Employed	25.5 (18.6)	Ref	16.0 (7.6)	Ref	8.0 (6.8)	Ref
Unemployed	28.0 (21.8)	-1.08 (-8.00 to 5.84)	21.4 (6.2)	3.88 (1.46 to 6.31)	14.8 (7.0)	5.69 (3.32 to 8.06)
Current student	26.1 (24.0)	-1.78 (-11.70 to 8.14)	17.1 (7.6)	-0.16 (-3.61 to 3.28)	9.7 (6.6)	0.84 (-2.44 to 4.12)
Living with others						
Living with others	26.4 (19.4)	Ref	16.5 (7.6)	Ref	8.4 (6.5)	Ref
Living alone	25.8 (21.4)	-1.13 (-7.28 to 5.02)	18.9 (7.3)	2.07 (-0.10 to 4.24)	12.6 (8.3)	3.73 (1.63 to 5.83)
Living without children	28.0 (22.8)	Ref	17.9 (7.6)	Ref	10.8 (7.9)	Ref
Living with children (own or partner's)	24.4 (16.6)	-2.82 (-8.44 to 2.80)	16.5 (7.5)	-0.71 (-2.68 to 1.26)	8.4 (6.5)	-1.7 (-3.66 to 0.25)
Danish born						
Danish born	26.2 (19.1)	Ref	17.2 (7.6)	Ref	9.5 (7.2)	Ref
Foreign born	25.7 (29.6)	0.24 (-11.1 to 11.55)	16.9 (6.6)	-0.19 (-4.14 to 3.77)	11.8 (8.2)	2.42 (-1.48 to 6.33)
Clinical characteristics						
Diabetes duration (per year)		-0.83 (-1.70 to 0.05)		0.05 (-0.26 to 0.35)		0.10 (-0.20 to 0.40)
Macrovascular complications, no						
Macrovascular complications, no	26.1 (20.0)	Ref	18.9 (9.4)	Ref	10.6 (7.4)	Ref
Macrovascular complications, yes						
Retinopathy, no	28.6 (19.3)	3.58 (-10.3 to 17.42)	17.1 (7.5)	-2.49 (-7.46 to 2.48)	9.6 (7.3)	-1.59 (-6.49 to 3.32)
Retinopathy, yes	26.7 (20.3)	Ref	17.2 (7.6)	Ref	9.8 (7.3)	Ref
CCI = 0	22.0 (16.9)	-4.59 (-13.4 to 4.27)	16.6 (7.5)	-0.35 (-3.47 to 2.77)	8.4 (7.0)	-1.41 (-4.48 to 1.67)
CCI ≥ 1	26.1 (19.5)	Ref	16.8 (7.5)	Ref	9.2 (7.0)	Ref
No glucose-lowering drugs	27.0 (22.8)	-2.07 (-9.64 to 5.49)	19.0 (7.9)	0.55 (-2.13 to 3.23)	11.6 (8.3)	1.38 (-1.22 to 3.99)
Non-insulin drugs only	21.1 (19.1)	Ref	16.2 (6.9)	Ref	8.9 (7.0)	Ref
Insulin only or in combination	27.6 (19.5)	6.81 (0.33 to 13.29)	17.5 (7.7)	1.63 (-0.73 to 3.98)	9.9 (7.1)	1.46 (-0.89 to 3.82)
Antidepressant medication, no	29.0 (22.1)	6.06 (-3.09 to 15.22)	17.5 (8.3)	0.65 (-2.31 to 3.60)	9.4 (8.6)	-0.52 (-3.59 to 2.55)
Antidepressant medication, yes	26.4 (20.3)	Ref	16.2 (7.5)	Ref	8.4 (6.8)	Ref
Psychiatric disorder, no*	25.3 (18.3)	-6.24 (-14.32 to 1.84)	22.4 (5.7)	4.18 (1.51 to 6.86)	15.6 (6.7)	5.98 (3.37 to 8.59)
Psychiatric disorder, yes*	25.9 (19.9)	Ref	21.9 (5.4)	Ref	14.5 (7.3)	Ref
Psychiatric disorder, yes*	30.3 (20.5)	0.64 (-10.20 to 11.47)	16.8 (7.6)	-3.23 (-6.76 to 0.30)	9.2 (7.1)	-3.75 (-7.23 to -0.28)
Healthcare services						
Diabetes consultation last 6 months						
No consultation	16.1 (14.7)	Ref	16.3 (5.8)	Ref	7.4 (5.0)	Ref
General practice	26.6 (20.7)	10.05 (-1.20 to 21.30)	17.1 (7.6)	0.36 (-3.63 to 4.35)	9.5 (7.0)	1.90 (-2.01 to 5.80)
Hospital outpatient clinic	28.8 (19.1)	11.32 (-0.61 to 23.24)	17.7 (7.9)	0.61 (-3.69 to 4.91)	10.3 (8.3)	1.73 (-3.15 to 6.61)
Diabetes education, yes						
Diabetes education, no	26.9 (20.4)	Ref	16.7 (7.7)	Ref	9.4 (7.9)	Ref
Diabetes education, no	25.4 (19.5)	-1.73 (-7.22 to 3.77)	17.8 (7.4)	1.08 (-0.85 to 3.02)	9.8 (6.6)	0.57 (-1.36 to 2.50)
Consulted a dietician, yes	27.8 (19.5)	Ref	17.2 (7.8)	ref	9.9 (7.5)	Ref
Consulted a dietician, no	24.2 (20.9)	-2.35 (-8.07 to 3.36)	17.2 (7.4)	0.60 (-1.38 to 2.58)	9.2 (7.1)	0.05 (-1.93 to 2.03)
Consulted psychologist, yes	24.8 (23.3)	Ref	13.3 (5.2)	Ref	6.3 (3.5)	Ref
Consulted psychologist, no	26.4 (20.1)	3.83 (-13.7 to 21.38)	17.3 (7.7)	4.47 (-1.25 to 10.19)	9.7 (7.4)	3.90 (-2.97 to 10.78)
Peer support group, yes	23.8 (24.2)	Ref	17.1 (7.6)	Ref	10.2 (8.3)	Ref
Peer support group, no	26.6 (19.8)	2.54 (-8.16 to 13.23)	17.2 (7.6)	0.20 (-3.52 to 3.91)	9.6 (7.2)	-0.37 (-4.03 to 3.29)

All estimates are adjusted for sex and age.

95% CI: 95% confidence intervals; Ref: Reference group (Alpha) in the linear regression model; PAID: Problem Areas in Diabetes Scale, 20 items, range 0–100; PSS: Perceived Stress Scale, 10 items, range 0–40; CESD-R-10: Short Form Centre for Epidemiologic Studies Depression Scale, 10 items, range 0–30; CCI: Charlson Co-morbidity Index.

*In- or outpatient contact within past 3 years with schizophrenia and related disorders, mood disorders, neurotic, stress-related and somatoform disorders, eating and sleep disorders or specific personality disorders.

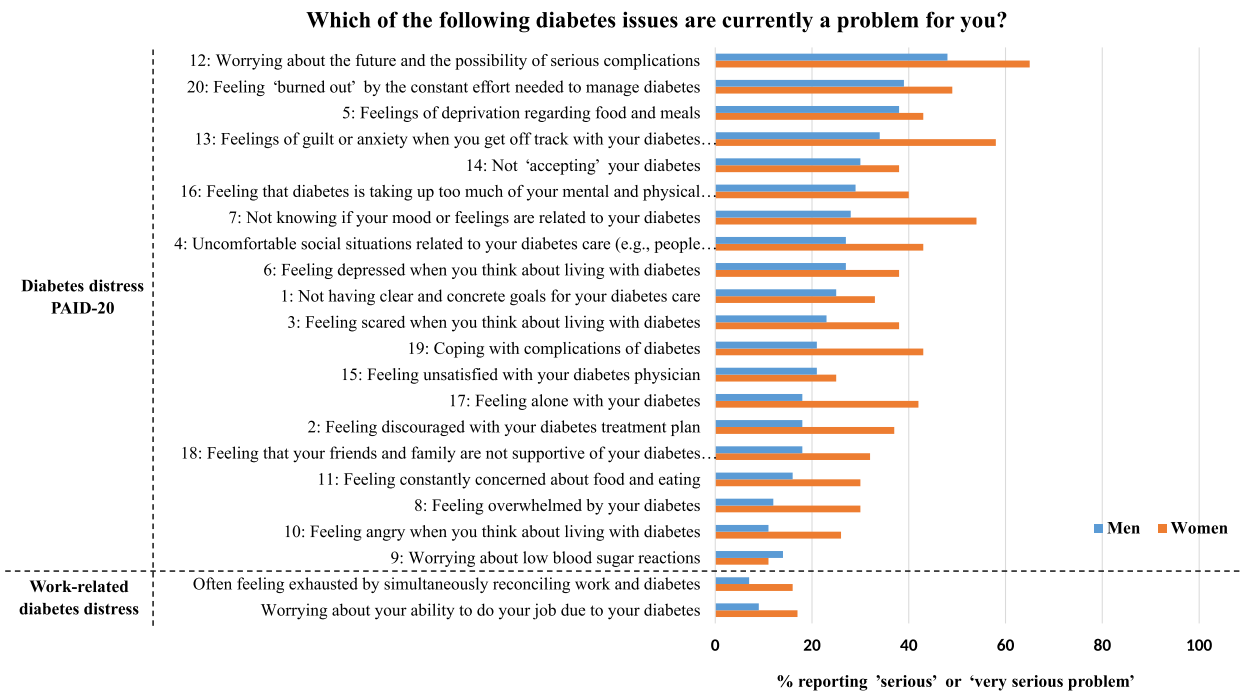


FIGURE 1 Item level results of the Problems Areas in Diabetes questionnaire (PAID-20) and two additional items about work-related diabetes distress among 200 adults aged 20–45 years with Type 2 diabetes.

well. However, with no medication use and a low diabetes distress level, these individuals could be missed in terms of clinical follow-up and may still benefit from health promotion activities.

Similar to findings in general populations with Type 2 diabetes [9,14], our study identified higher levels of emotional problems among women. Higher prevalence of affective disorders are generally recognized among women, with possible neurobiological explanations [27]. Further, Perrin *et al.* [9] argue that men and women process and express diabetes-related emotions differently, which may explain the differences in our self-reported measures. However, further knowledge is needed about the significance of gender differences in mental well-being to the management and outcomes of early-onset Type 2 diabetes.

Since the levels of perceived stress and depressive symptoms were substantially higher than the diabetes distress level, and since they were associated with socio-demographic and not with clinical characteristics, we believe that the main emotional burden in adults with early-onset Type 2 diabetes in Denmark is linked to social circumstances and has less to do with diabetes-related concerns. This has important implications as to how diabetes care should be delivered. For example, Fisher *et al.* have argued that non-diabetes specific problems may negatively impact on diabetes but often go untreated, and to address this, they proposed a model for uncovering and separately addressing the source and severity of emotional problems [11]. In the UK, a social care programme consisting of financial, employment or

family counselling was offered along with physical and psychological diabetes care [28], and similar approaches may be relevant for younger adults with Type 2 diabetes.

In Denmark, as in many other countries, Type 2 diabetes care is offered primarily in general practice. Thus, it is a key challenge to ensure that targeted education and support options for younger adults with Type 2 diabetes are made available in primary care settings, and that specialized clinical knowledge is made available to general practitioners, for example, through updated guidelines or education sessions.

In our study, only half of the respondents had attended diabetes education. This may be because younger adults experience practical barriers and have different needs and preferences than their older counterparts [4,6,7,29,30]. Furthermore, our finding of different levels and types of emotional problems in different subgroups indicates a need for adapted and differentiated initiatives, for example, for women, for those who are unemployed, and for those who suffer from co-morbid mental illness. Involving members of the target group in the co-design of services could lead to improved adaption to the life circumstances and specific needs of younger adults with Type 2 diabetes.

Strengths and limitations

The main strength of the present study is the use of a national cohort linking psychosocial and clinical data in adults with early-onset Type 2 diabetes. Considering the high emotional

burden in our sample and also that we did not offer an incentive for participation, we obtained a relatively high response rate. However, although clinical characteristics were similar between respondents and non-respondents, bias due to non-response is still possible. For example, those with a very high level of psychosocial problems may be under-represented, due to the resources required to complete the survey. Further, although the DD2 cohort recruits nationwide, ethnic minority groups are highly underrepresented in this study. The cross-sectional design impeded any conclusion about causal relations, and the limited sample size yielded broad confidence intervals with the risk of overlooking associated characteristics. Furthermore, in the regression analysis with the PAID and CESD-R-10 scores, the residual showed some deviance from the normal distribution. Therefore, the interpretation of estimates for variables with small cell counts should be made with caution. While capturing some life-stage factors in the survey, other important issues, such as diabetes-related stigma, worries about heredity and caring for children, financial concerns, or insecurity in life transitions [6], were not captured in the survey. Nonetheless, our study is the first in Denmark to examine the psychosocial characteristics of younger adults with Type 2 diabetes, and thereby contributes to improving health services in this priority population.

Conclusion

Our study revealed a high prevalence of emotional problems, with a higher prevalence of perceived stress and depressive symptoms than of diabetes distress among adults with early-onset Type 2 diabetes in Denmark. The results indicate that the main source of emotional problems in this group may be perceived stress or depressive symptoms related to socioeconomic circumstances and emotional distress related to Type 2 diabetes.

Acknowledgements

We thank project coordinator Jens Steen Nielsen and members of the steering committee of the Danish Centre for Strategic Research in Type 2 Diabetes (DD2) for their collaboration. We are grateful to all the participants of the survey study.

Funding sources

The Danish Centre for Strategic Research in Type 2 Diabetes (<http://www.dd2.nu/>) is supported by the Danish Agency for Science (grant nos. 09-067009 and 09-075724). DD2 is also supported by the Danish Health and Medicines Authority, the Danish Diabetes Association and the Novo Nordisk A/S (grant no. NNF 16SA0024768). This study was supported by research grants from the Danish Diabetes Academy,

supported by the Novo Nordisk Foundation, and by the Central Denmark Region, Aarhus University and the Riisfort Foundation. All funding was awarded as unrestricted grants.

Competing interests

None declared.

Ethical approval

The study was approved by the Central Denmark Region Committees On Health Research Ethics, and informed consent was obtained from all participants. This research study was conducted in accordance with the guidelines of the Declaration of Helsinki.

References

- 1 Lascar N, Brown J, Pattison H, Barnett AH, Bailey CJ, Bellary S. Type 2 diabetes in adolescents and young adults. *Lancet Diabetes Endocrinol* 2018; 6: 69–80.
- 2 Steinarsson AO, Rawshani A, Gudbjornsdottir S, Franzen S, Svensson AM, Sattar N. Short-term progression of cardiometabolic risk factors in relation to age at type 2 diabetes diagnosis: a longitudinal observational study of 100,606 individuals from the Swedish National Diabetes Register. *Diabetologia* 2018; 61: 599–606.
- 3 Song SH, Hardisty CA. Early-onset Type 2 diabetes mellitus: an increasing phenomenon of elevated cardiovascular risk. *Expert Rev Cardiovasc Ther* 2008; 6: 315–322.
- 4 Hessler DM, Fisher L, Mullan JT, Glasgow RE, Masharani U. Patient age: a neglected factor when considering disease management in adults with type 2 diabetes. *Patient Educ Couns* 2011; 85: 154–159.
- 5 Browne JL, Nefs G, Pouwer F, Speight J. Depression, anxiety and self-care behaviours of young adults with Type 2 diabetes: results from the International Diabetes Management and Impact for Long-term Empowerment and Success (MILES) Study. *Diabet Med* 2015; 32: 133–140.
- 6 Rasmussen B, Terkildsen Maindal H, Livingston P, Dunning T, Lorentzen V. Psychosocial factors impacting on life transitions among young adults with type 2 diabetes: an Australian - Danish qualitative study. *Scand J Caring Sci* 2016; 30: 320–329.
- 7 Browne JL, Scibilia R, Speight J. The needs, concerns, and characteristics of younger Australian adults with Type 2 diabetes. *Diabet Med* 2013; 30: 620–626.
- 8 Polonsky WH, Anderson BJ, Lohrer PA, Welch G, Jacobson AM, Aponte JE et al. Assessment of diabetes-related distress. *Diabetes Care* 1995; 18: 754–760.
- 9 Perrin NE, Davies MJ, Robertson N, Snoek FJ, Khunti K. The prevalence of diabetes-specific emotional distress in people with Type 2 diabetes: a systematic review and meta-analysis. *Diabet Med* 2017; 34: 1508–1520.
- 10 Pintaudi B, Lucisano G, Gentile S, Bulotta A, Skovlund SE, Vespasiani G et al. Correlates of diabetes-related distress in type 2 diabetes: findings from the benchmarking network for clinical and humanistic outcomes in diabetes (BENCH-D) study. *J Psychosom Res* 2015; 79: 348–354.
- 11 Fisher L, Gonzalez JS, Polonsky WH. The confusing tale of depression and distress in patients with diabetes: a call for greater clarity and precision. *Diabet Med* 2014; 31: 764–772.

- 12 Ali S, Stone MA, Peters JL, Davies MJ, Khunti K. The prevalence of co-morbid depression in adults with Type 2 diabetes : a systematic review and meta-analysis. *Diabet Med* 2006; 1165–1173.
- 13 Pouwer F, Nefs G, Nouwen A. Adverse effects of depression on glycemic control and health outcomes in people with diabetes. *Endocrinol Metab Clin NA* 2013; 42: 529–544.
- 14 Lloyd CE, Nouwen A, Sartorius N, Ahmed HU, Alvarez A, Bahendeka S *et al*. Prevalence and correlates of depressive disorders in people with Type 2 diabetes: results from the International Prevalence and Treatment of Diabetes and Depression (INTERPRET-DD) study, a collaborative study carried out in 14 countries. *Diabet Med* 2018; 35: 760–769.
- 15 Cohen S. Perceived stress in a probability sample of the United States. In Spacapan S, Oskamp S (Eds.), *The Claremont Symposium on Applied Social Psychology. The social psychology of health*. Thousand Oaks, CA, USA: Sage Publications; 1988, pp. 31–67.
- 16 Pouwer F, Kupper N, Adriaanse MC. Does emotional stress cause type 2 diabetes mellitus? A review from the European Depression in Diabetes (EDID) Research Consortium. *Discov Med* 2010; 9: 112–118.
- 17 Danish Health Data Authority [Sundhedsdatastyrelsen]. Registry for selected chronic conditions and severe mental illnesses [Register for udvalgte kroniske sygdomme og svære psykiske lidelser] 2019. Available at <http://esundhed.dk/sundhedsregistre/uks/uks01/Sider/Tabel.aspx>. Last accessed 9 May 2019.
- 18 Bo A, Thomsen RW, Nielsen JS, Nicolaisen SK, Beck-Nielsen H, Rungby J *et al*. Early onset type 2 diabetes: age gradient in clinical and behavioural risk factors in 5115 persons with newly diagnosed Type 2 diabetes - results from the DD2 study. *Diabetes Metab Res Rev* 2018; 34: 3.
- 19 Nielsen JS, Thomsen RW, Steffensen C, Christiansen JS. The Danish Centre for Strategic Research in Type 2 Diabetes (DD2) study: implementation of a nationwide patient enrollment system. *Clin Epidemiol* 2012; 4: 27–36.
- 20 Thomsen RW, Friberg S, Nielsen JS, Schroll H, Johnsen SP. The Danish Centre for Strategic Research in Type 2 Diabetes (DD2): organization of diabetes care in Denmark and supplementary data sources for data collection among DD2 study participants. *Clin Epidemiol* 2012; 4: 15–19.
- 21 Hansen UM, Olesen K, Browne JL, Skinner TC, Willaing I. A call for inclusion of work-related diabetes distress in the spectrum of diabetes management: results from a cross-sectional survey among working people with type 1 diabetes. *Diabetes Res Clin Pract* 2018; 140: 139–147.
- 22 Prior A, Fenger-Grøn M, Larsen KK, Larsen FB, Robinson KM, Nielsen MG *et al*. The association between perceived stress and mortality among people with multimorbidity: a prospective population-based cohort study. *Am J Epidemiol* 2016; 184: 199–210.
- 23 Andersen EM, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *Am J Prev Med* 1994; 10: 77–84.
- 24 Ke C, Lau E, Shah BR, Stukel TA, Ma RC, So WY *et al*. Excess burden of mental illness and hospitalization in young-onset type 2 diabetes: a population-based cohort study. *Ann Intern Med* 2019; 170: 145–154.
- 25 Danish Health Data Authority [Sundhedsdatastyrelsen]. Medication use - overview [MEDICINFORBRUG - INDBLIK] 2017. Available at <https://sundhedsdatastyrelsen.dk/da/tal-og-analyser/analyser-og-rapporter/laegemidler/emnespecifikke-analyser/analyser-om-antidepressiva>. Last accessed 29 July 2019.
- 26 Danish Health Authority [Sundhedsstyrelsen]. Health of the Danish population. The National Health Profile [Danskernes sundhed. Den Nationale Sundhedsprofil 2017] 2017. Available at <https://www.sst.dk/da/udgivelser/2018/-/media/73EADC242CDB46BD8ABF9DE895A6132C.ashx>. Last accessed 10 May 2019.
- 27 Rubinow DR, Schmidt PJ. Sex differences and the neurobiology of affective disorders. *Neuropsychopharmacology* 2019; 44: 111–128.
- 28 Doherty AM, Gayle C, Morgan-Jones R, Archer N, Laura-Lee Ismail K *et al*. Improving quality of diabetes care by integrating psychological and social care for poorly controlled diabetes: 3 dimensions of care for diabetes. *Int J Psychiatry Med* 2016; 51: 3–15.
- 29 Savage S, Dabkowski S, Dunning T. The education and information needs of young adults with type 2 diabetes: a qualitative study. *J Nurs Healthc Chronic Illn* 2009; 1: 321–330.
- 30 Lake AJ, Browne JL, Rees G, Speight J. What factors influence uptake of retinal screening among young adults with type 2 diabetes? A qualitative study informed by the theoretical domains framework. *J Diabetes Complications* 2017; 31: 997–1006.