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Psychosocial health in people with diabetes during the first three months of the COVID-19 pandemic in Denmark

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ABSTRACT

Aims: To analyze trajectories of psychosocial health among people with diabetes during the first three months of lockdowns and reopenings of the COVID-19 pandemic in Denmark.
Methods: An online longitudinal survey of 2430 people with diabetes consisting of six questionnaire waves (Q1-Q6) was conducted between March 19 and June 25, 2020. Psychosocial outcomes assessed were COVID-19 worries, quality of life, feelings of social isolation, psychological distress, diabetes distress, anxiety, and general and diabetes-specific loneliness. Trajectories in psychosocial health were analyzed with linear multilevel mixed-effects models. Subgroup analyses were conducted.
Results: In total, 1366 (56%) people with diabetes responded to the first questionnaire. COVID-19 worries, feelings of social isolation, psychological distress, anxiety and general loneliness had all improved at Q6 compared to Q1 ($p < 0.001$). In general, improvements in psychosocial health started after the first reopening phase (April 15); however, general loneliness increased up to the first reopening phase ($p \leq 0.001$) before decreasing, and quality of life decreased up to the first reopening phase ($p = 0.002$), with no improvements to follow. Subgroup analyses revealed that women had larger decreases in feelings of social isolation ($p < 0.001$) and in psychological distress ($p = 0.035$) and increases in quality of life ($p < 0.001$), between Q1 and Q6, compared to men.
Conclusions: Psychosocial health in people with diabetes improved following reopening of society. However, increases in loneliness and decreases in quality of life during lockdown indicates a potential need to mitigate the acute effects of such policies.

1. Introduction

The coronavirus disease 2019 (COVID-19) was declared a global pandemic by the World Health Organization on March 11, 2020.[1] Since then, the pandemic has taken its toll on societies across the world, including economies, social relations, and physical and mental well-being. Prior to the pandemic's emergence in the Western world, a study of 1210 respondents documented the psychological impact of the COVID-19 pandemic in China. The study found that 54% of respondents rated the psychological impact of the COVID-19 outbreak as moderate or severe.[2] Furthermore, people with a chronic illness, such as diabetes, experienced higher levels of stress, anxiety and depression compared to people with no chronic illness.[2] Early studies of general populations in the Western world also documented psychological impacts of the pandemic. For example, a study in the general population of the UK found that the prevalence of clinically relevant levels of mental distress increased from 19% to 27% between 2019 and April 2020 (one month into the lockdown).[3] Similarly, a study of the general population from the USA found that 36% of Americans reported that the COVID-19 pandemic seriously affected their mental health, while 48% were anxious about the risk of infection.[4]

COVID-19 is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and presents, in most people, with symptoms like a common cold.[5] However, certain groups have an increased risk of experiencing more severe symptoms. As such, people with diabetes have been identified as a high-risk group with a two-fold higher mortality rate and a three-fold higher risk of a more severe COVID-19 infection when compared to people without diabetes.[6,7] COVID-19-related mortality rates in people with diabetes are highest for those who are obese or underweight, and those who suffer from cardiovascular and/or renal complications of diabetes.[8–10] Whereas some studies suggest high HbA1c as an important risk factor for COVID-19 related mortality,[8] other studies dispute this.[11]

To date, the role of COVID-19 in the interplay between diabetes and psychosocial health has mostly been studied in cross-sectional studies.[12–16] We found in a preceding study that having diabetes-specific worries about the COVID-19 pandemic was associated with

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poorer psychosocial health with regards to feelings of isolation, loneliness and diabetes distress.[12] Another study found that people with diabetes were more worried about being infected than people without diabetes.[15] Thus, it is likely that the pandemic exacerbated psychosocial challenges that are often experienced under "normal" circumstances by people with diabetes.

Research conducted among people with diabetes prior to the COVID-19 pandemic shows that women compared to men, younger compared to older people, people with type 1 compared to type 2 diabetes, and people with a history of mental illness compared to people without, experience higher levels of diabetes distress and lower levels of mental well-being.[17–22] Social ties also impact psychosocial health in people with diabetes. For instance, people living alone have lower psychological well-being compared to people living with a partner.[23]

The aim of this paper was to analyze trajectories of general and diabetes-specific psychosocial health among people with diabetes during the first three months of lockdowns and reopenings of the COVID-19 pandemic in Denmark.

2. Materials and methods

2.1. Study design and setting

A longitudinal study was conducted using online questionnaires that were distributed via e-mail to Danish adults (≥18 years) with diabetes who were members of user panels at either Steno Diabetes Center Copenhagen, a specialist diabetes clinic, or the Danish Diabetes Association. Data were collected between March 19 and June 25, 2020. Thus, the information analyzed in this paper ranges from the first week to roughly three months after the first lockdown ensued in Denmark. Details of survey development, user panels and recruitment strategy have been reported previously.[12,24] Briefly, the survey is a diabetes-specific version of the Copenhagen Corona-Related Mental Health questionnaire,[24] and consisted of six questionnaire waves (Q1-Q6). All respondents who answered the first questionnaire (Q1) received questionnaires at all subsequent waves (Q2-Q6) regardless of having missed one or more waves. The study was approved by the Danish Data Protection Agency (P-2020-271).

Fig. 1 provides a timeline overview of the first three months of the COVID-19 pandemic in Denmark, including details on key messages from the Danish Health Authority, information on lockdown and reopening phases, and questionnaire distribution dates.

2.2. Survey content

Questions about psychosocial health were included in all six questionnaires; items on health and sociodemographic status were only included at Q1 and Q6. Wording of each item in the survey can be found in the Supplementary material (S1).

2.2.1. Psychosocial health

Psychosocial health was assessed with visual analogue scales (VAS) and questionnaire scales.

Worries about COVID-19, *quality of life* and *feelings of social isolation*, respectively, were measured on 1–10-point VAS with 1 representing the lowest degree and 10 the highest.

Psychological distress was measured with a five-item questionnaire scale specifically developed to assess distress during the COVID-19 pandemic.[25] The scale consists of adapted items from the validated GAD-7, CES-D and Event Scale Revised questionnaire scales, and asks how often in the past week the respondent has experienced being 1) nervous, anxious, or on edge, 2) depressed, 3) lonely, 4) hopeful about the future, and 5) had physical reactions that can be linked to the Coronavirus. The scale has four response categories ranging from 'rarely or none of the time (<1 day)' to 'most or all of the time (5-7 days)', weighing 1–4 points in the total score calculation (range 5–20), respectively.

Diabetes distress was measured with two items from the Diabetes Distress Scale[26]: '*feeling overwhelmed by the demands of living with diabetes*' and '*feeling that I am often failing with my diabetes routine*'

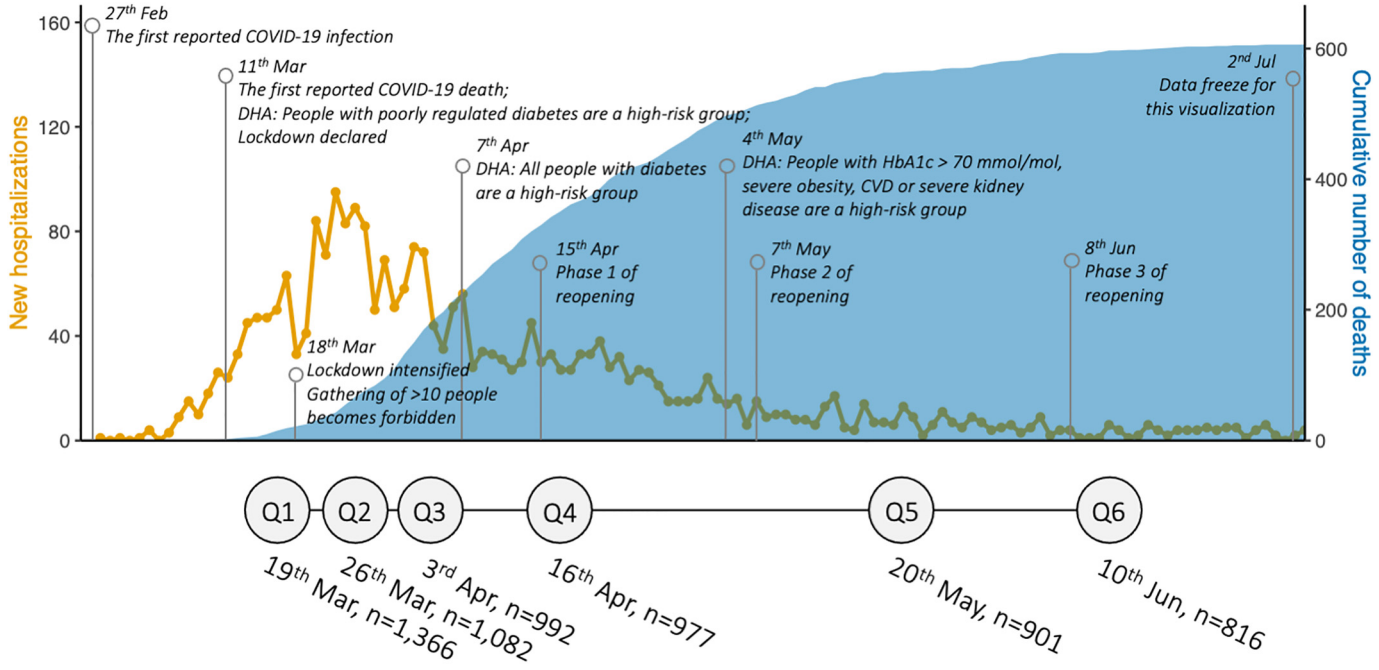


Fig. 1. Timeline of questionnaire distribution and pivotal events during the COVID-19 pandemic in Denmark in 2020. Abbreviations: DHA, Danish Health Authority; Q, questionnaire. Q1 and Q2 were each open one week from the opening date and Q3-Q6 were each open two weeks from the opening date. Phase 1 of reopening included reopening of elementary schools from grade 0–5, child services and liberal professions (i.e., hairdressers, dentists etc.). Phase 2 of reopening included reopening of elementary schools from grade 6–10, high schools and universities, malls and retailers, restaurants, zoos, libraries, churches, museums, cinemas, theaters etc. Nightlife remained closed. Phase 3 involved increasing the ban of >10 people gatherings to 50 and the reopening of public swimming pools, gyms, casinos, and nightlife (partly).

Table 1
Study sample characteristics at Q1 ($n = 1366$).

Variables	Descriptive statistics	Missing observations
Age in years	61.7 (12.8), [55, 64, 71]	137
Age in groups		
<65 years	615 (50)	
65–79 years	570 (46.4)	
≥80 years	44 (3.6)	
Sex		62
Female	580 (44.5)	
Male	724 (55.5)	
Education		157
Primary school	79 (6.5)	
Secondary (high school/vocational)	395 (32.7)	
Short-medium-cycle	681 (56.3)	
Long-cycle	54 (4.5)	
Cohabitation status		165
Lives alone	314 (26.1)	
Lives with partner and/or children	887 (73.9)	
Employment status		
Employed	429 (35.5)	165
Retired	669 (55.3)	
Sick leave or unemployed	111 (9.2)	
Diabetes type		83
Type 1	461 (35.9)	
Type 2	822 (64.1)	
Diabetes duration	19.5 (15), [8, 16, 26]	270
Diabetes complications[a]		30
0	980 (73.4)	
1	266 (19.9)	
2+	90 (6.7)	
HbA1c (mmol/mol)	56.6 (14.5), [48, 54, 61.8]	554[d]
HbA1c (%)	7.3 (3.5), [6.5, 7.1, 7.8]	
HbA1c in groups		554[d]
Low (≤70 mmol/mol/11.1%)	703 (86.6)	
High (>70 mmol/mol/11.1%)	109 (13.4)	
Comorbidities[b]		79
0	560 (43.5)	
1+	727 (56.5)	
Mental illness[c]		79
0	1137 (88.3)	
1+	150 (11.7)	
COVID-19 worries, range: 1–10	5.9 (2.49), [4, 6, 8]	139
Quality of life, range: 1–10	7.1 (1.9)	126
Feelings of social isolation, range: 1–10	5.5 (2.7)	156
Psychological distress, range: 5–20	7.7 (2.9), [5, 7, 9]	119
Diabetes distress, range: 1–6	1.8 (1.00), [1, 1.5, 2]	154
None to low diabetes distress (DDS2 ≤ 2)	914 (75.4)	
Moderate to high diabetes distress (DDS2 > 2)	298 (24.6)	
Anxiety, range: 0–4	0.5 (0.66), [0, 0.25, 0.75]	119
<10% risk of anxiety disorder	1004 (80.5)	
20% risk of anxiety disorder	182 (14.6)	
30% risk of anxiety disorder	45 (3.6)	
40% risk of anxiety disorder	13 (1.1)	
45% risk of anxiety disorder	3 (0.2)	
General loneliness, range: 3–9	4.8 (1.64), [3, 5, 6]	154
Often or sometimes lack company	690 (56.9)	
Often or sometimes feel left out	348 (28.7)	
Often or sometimes feel isolated from others	742 (61.2)	
Diabetes-specific loneliness, range: 2–6	2.7 (1.13), [2, 2, 3]	154
Often or sometimes miss someone to talk to about diabetes	279 (23)	
Often or sometimes feel lonely with diabetes	393 (32)	

Descriptive statistics for categorical data are given as frequency (percent) and for continuous data as mean (standard deviation) with median and percentiles in brackets [P25, median, P75]. Abbreviations: P25/P75, 25th/75th percentiles.

[a] Diabetes complications include 1 or more of the following: retinopathy, nephropathy, neuropathy, foot ulcer and cardiovascular disease.

[b] Comorbidities include 1 or more of the following: asthma, atherosclerosis, arthritis, back disease, cancer, chronic obstructive pulmonary disease, impaired hearing, migraine and stroke.

[c] Mental illness includes anxiety and depression or whether the participant had ever been diagnosed with any other psychiatric disorder by a physician.

[d] The relatively large amount of missing data on HbA1c is primarily due to underreporting by people with type 2 diabetes.

(DDS2). The response categories ranged from 'not a problem' to 'a very serious problem'. The total distress score was calculated as the average of the two items, thus ranging from 1 to 6, where a score ≥ 2 indicates elevated diabetes distress.[27]

Anxiety was measured with the Symptom Check List-revised anxiety subscale (SCL-ANX4).[28] The SCL-ANX4 contains four items about 1) feelings of fear, 2) nervousness, 3) terror/panic and 4) excessive worry, with response categories 'not at all', 'a little', 'moderately', 'quite a bit', and 'extremely'. To accommodate the rapidly changing situation during the pandemic, a one-week recollection period was chosen over the usual four-week timespan used for the scale. The final SCL-ANX4 score is the average of the responses to each item and ranges from 0 to 4. The likelihood of having an anxiety disorder at an average score of 0 corresponds to <10%, whereas it is 45% at an average score of 4.

General loneliness was measured with the three-item UCLA Loneliness Scale (UCLA).[29] The UCLA asks how much the respondent has felt starved for company, left out, and isolated from others, and contains the response categories 'never/rarely', 'sometimes', and 'often', providing a total score from 3 to 9. *Diabetes-specific loneliness* (UCLA-D) was assessed with two questions, similar to the format of the UCLA, about the *degree of feeling alone with diabetes* and *missing someone to talk to about diabetes*.[30]

2.2.2. Participant characteristics

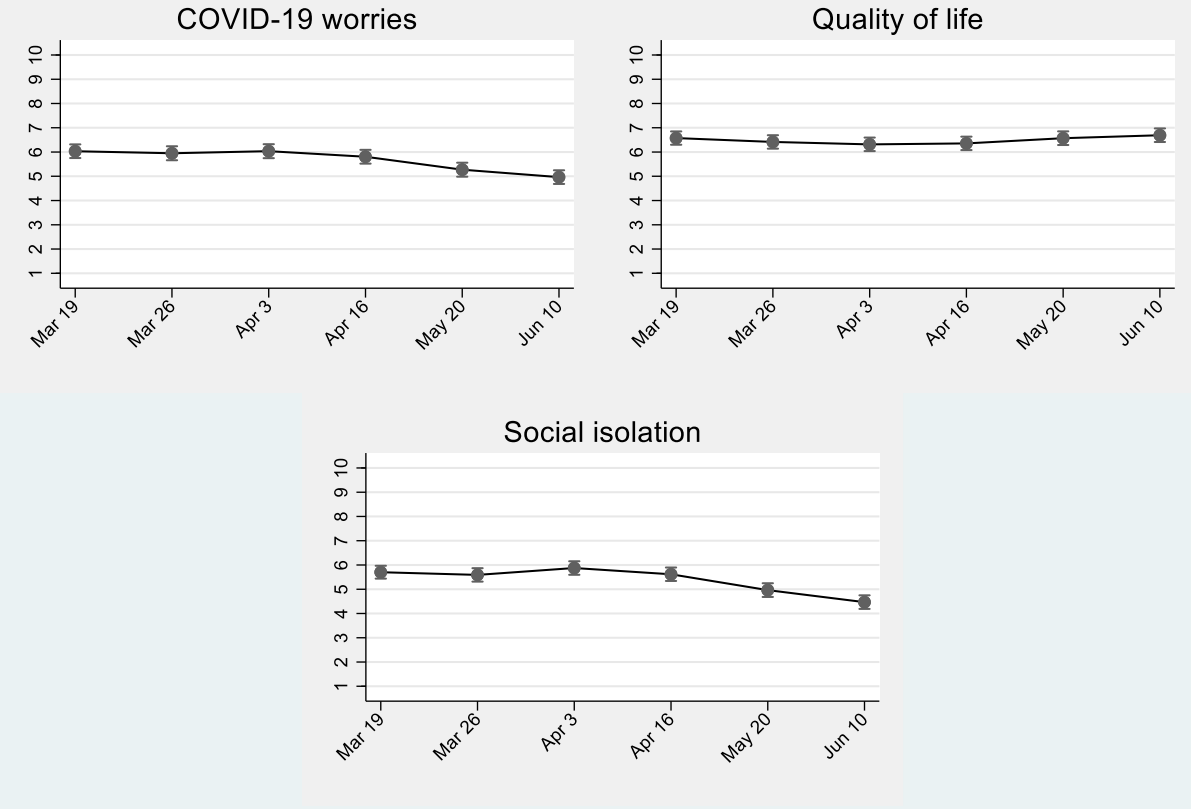
The survey collected information on age, sex, education, cohabitation status, employment status, diabetes type, duration and complications, HbA1c, comorbidities and mental illness history.

2.3. Statistical methods

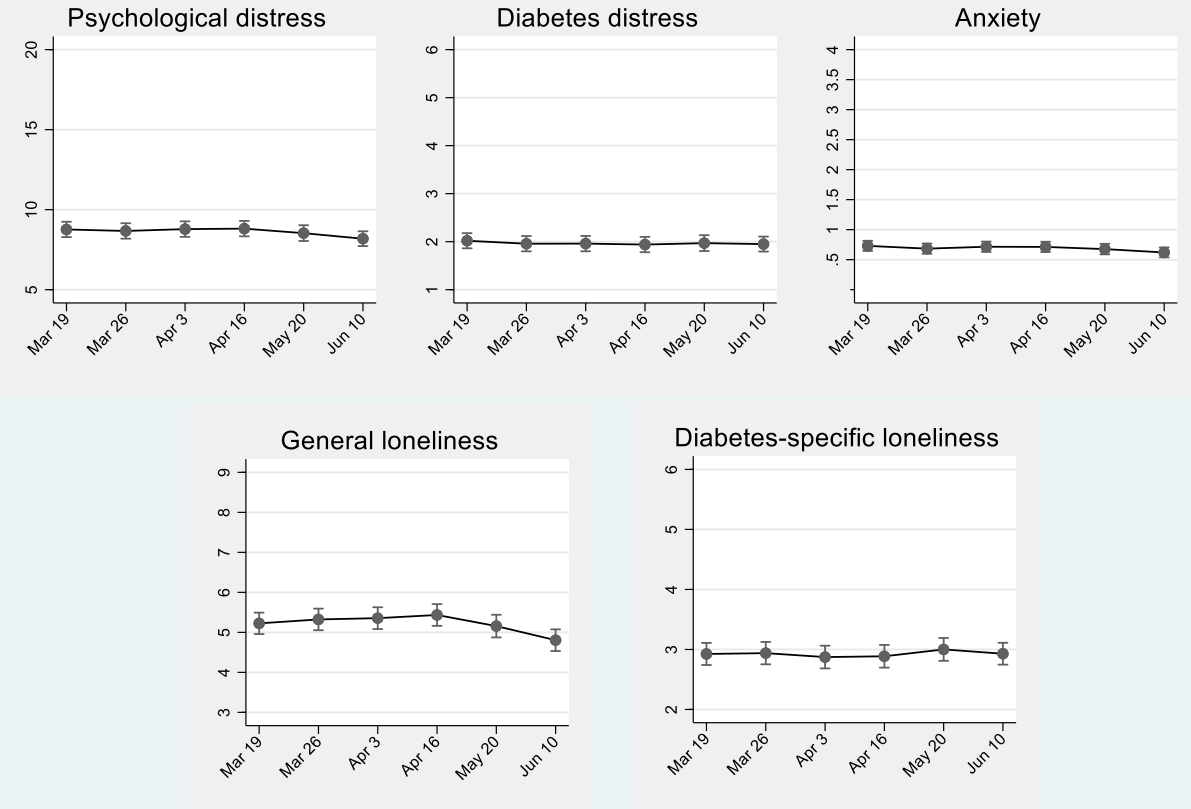
Continuous variables are reported as means with standard deviations, and as medians with 25th and 75th percentiles. Categorical data are reported as frequencies and proportions. Marginal differences in participant characteristics between each questionnaire as well as between Q1 and Q6 were tested with Student's *t*-tests and Wilcoxon tests for normally and non-normally distributed data, respectively, and with χ^2-tests for categorical data.

Linear multilevel mixed-effects (LMM) regression models were used to analyze trajectories of psychosocial health over time while accounting for between and within-subject variation. LMM models incorporate both fixed effects (population-level effects) and random effects (individual-level effects) by specification of a so-called "random intercept, random slope" model structure. The fixed effects (explanatory) part of each LMM was selected using the model-building algorithm least absolute shrinkage and selection operator (LASSO). The LASSO algorithm optimizes model parsimony and prediction accuracy, effectively producing the most accurate model in the simplest way possible. The random effects parts of each LMM consisted of an indicator variable for each respondent (random intercept) and a questionnaire wave indicator variable for each respondent (random slope). Missing data were handled using complete case analysis (listwise deletion).

To analyze differences over time in subgroups, interaction terms between the questionnaire wave indicator variable and explanatory variables of interest were added to the LMM models, using Q1 values as reference. Analyzed subgroups were defined by sex (women/men), cohabitation status (alone/with someone else), diabetes type (type 1/type 2), number of diabetes complications (0, 1 or 2+), and history of mental illness (yes/no). Age and HbA1c groups were also analyzed. The Danish Health Authority (DHA) categorizes age-related risk of severe COVID-19 infection into three age groups; <65 years, 65–79 years, and ≥80 years.[31] The age variable was split into three categories accordingly. HbA1c groups were defined as high (>70 mmol/mol/11.1%) or low (≤70 mmol/mol/11.1%) according to the DHA's assessment of high-risk individuals with diabetes. Only statistically significant interaction terms at a 5% level ($P \leq 0.05$) were explored further in within-group analyses to avoid erroneous inference. All models were estimated in



Panel A



Panel B

Stata 15.1 using restricted maximum likelihood and assuming unstructured covariance matrices.

3. Results

3.1. Retention and baseline characteristics

The first questionnaire was distributed to 2430 individuals with diabetes of whom 1366 (56%) responded (Supplementary material S2). A response rate between 70 and 80% of the initial 1366 respondents was maintained at Q2-Q4, dropping to 66% and 60% at Q5 and Q6, respectively.

At baseline, psychosocial health mean scores were as follows: COVID-19 worries = 5.9 (range: 1–10); Quality of life = 7.1 (1−10); Social isolation = 5.5 (1–10); Psychological distress = 7.7 (5–20); DDS2 = 1.8 (1–6); SCL-ANX4 = 0.5 (0–4); UCLA = 4.8 (3–9); UCLA-D = 2.7 (2–6) (Table 1). There were roughly 25% who had moderate to severe diabetes distress, and 19.5% of the sample had a 20% risk or more of an anxiety disorder. More than half of the respondents often or sometimes felt either lack of company or isolated from others, while just under 1/3 often or sometimes felt left out. Responses to the UCLA-D revealed that one in four of the respondents often or sometimes missed someone to talk to about diabetes and that one in three did so with regards to feeling alone with their diabetes.

There were no statistically significant differences in socioeconomic or health status characteristics between questionnaires, nor any differences between Q1 and Q6.

3.2. Trajectories in psychosocial outcomes

Fig. 2 and Table 2 show trajectories and regression coefficients, respectively, from Q1 through Q6 for each psychosocial outcome assessed by the VAS and the questionnaire scales. Zoomed-in versions and full regression tables of Fig. 2 can be found in the Supplementary material (S3-S4).

Degree of COVID-19 worries went unchanged from Q1-Q3 and began to decrease at Q4 ($\Delta = -0.23, p = 0.005$), Q5 ($\Delta = -0.76, p < 0.001$) and Q6 ($\Delta = -1.07, p < 0.001$) compared to Q1. Quality of life decreased at Q2 ($\Delta = -0.159, p = 0.016$), Q3 ($\Delta = -0.259$, p < 0.001) and Q4 ($\Delta = -0.220, p = 0.002$) compared to Q1 and remained at that level through Q6. Feelings of social isolation did not change at Q2-Q4 compared to Q1, but decreased at Q5 ($\Delta = -0.738, p < 0.001$) and Q6 ($\Delta = -1.234, p < 0.001$) compared to Q1.

Psychological distress decreased at Q5 ($\Delta = -0.23, p = 0.020$) and Q6 ($\Delta = -0.58, p < 0.001$) compared to Q1 after having increased from Q2 to Q4 (0.14, $p = 0.022$). Diabetes distress decreased at Q2 ($\Delta = -0.06, p = 0.034$) and Q4 ($\Delta = -0.08, p = 0.009$) compared to Q1, but no statistically significant changes were found at Q5 and Q6 compared to Q1. Comparing Q1 to Q6, both anxiety ($\Delta = -0.11$, p < 0.001) and general loneliness ($\Delta = -0.42$, p < 0.001) decreased. However, general loneliness increased from Q1 to Q4 ($\Delta = 0.21$, p < 0.001) before decreasing. Diabetes-specific loneliness remained stable when comparing Q1 to Q6, except for Q5 where a statistically significant increase was observed (0.08. $p = 0.037$).

3.3. Subgroup findings

Figures and underlying regression tables of subgroup analyses can be found in the Supplementary material (S5-S11).

3.3.1. Age and sex

The oldest age group, compared to the youngest, had a statistically significant decrease in quality of life at Q6 compared to Q1 (between-group difference − 1.59, $p = 0.003$). Women had a larger decrease in feelings of social isolation (between-group difference − 0.697, $p < 0.001$) and psychological distress (−0.44, $p = 0.035$) from Q1 to Q6 compared to men. There were statistically significant within-group improvements for both men and women with regards psychological distress when comparing Q1 to Q6 (−0.39, $p = 0.005$ and − 0.83, $p < 0.001$, respectively). Quality of life also increased more in women compared to men at Q3-Q6 (between-group differences: Q3: 0.339, $p = 0.017$ | Q4: 0.372, $p = 0.009$ | Q5: 0.311, $p = 0.042$ | Q6: 0.519, $p = 0.003$) relative to Q1. Within-group analyses revealed that whereas quality of life had increased in women at Q6 (0.426, $p = 0.001$) compared to Q1, it decreased in men at Q2-Q4 compared to Q1 (Q2: −0.221, $p = 0.010$ | Q3: −0.394, $p < 0.001$ | Q4: −0.369, p < 0.001). Anxiety levels had also decreased more for women compared to men at Q6 (between-group difference − 0.15, p < 0.001). Within-group analysis revealed a statistically significant decrease at Q6 only for women (−0.19, p < 0.001).

3.3.2. Cohabitation status

Respondents living with a partner and/or children had a larger increase in diabetes-specific loneliness at Q5 and Q6 relative to Q1 compared to respondents living alone (between-group differences: Q5: 0.24, p < 0.001 | Q6: 0.20, $p = 0.031$), and a larger increase in general loneliness at Q5 (0.331, $p = 0.021$).

3.3.3. Mental illness history

Compared to Q1, having a history of mental illness was associated with a greater decrease in COVID-19 worries at Q2 (−0.67, $p = 0.010$), Q3 (−0.59, $p = 0.032$) and Q4 (−0.55, $p = 0.050$) compared to having no history of mental illness; however, this between-group difference disappeared at Q5 and Q6. The same tendency was observed for anxiety, with a larger decrease in anxiety in respondents with a history of mental illness (Q2: −0.08, $p = 0.065$ | Q3: −0.18, $p < 0.001$ | Q4: −0.21, p < 0.001) compared to respondents without. Psychological distress decreased more in respondents with a history of mental illness at Q2 through Q4 compared to Q1 than in respondents without (between-group difference − 0.73 - -1.18, $p < 0.001$), but this difference was not statistically significant at Q5 and Q6. Within-group analyses revealed that psychological distress decreased only in the mental illness group from Q1 to Q6 (−0.61, p < 0.001). Diabetes distress initially decreased more in respondents with a history of mental illness compared to no mental illness; however, this between-group difference was statistically significant exclusively at Q4 (−0.32, $p < 0.001$).

3.3.4. Diabetes type, diabetes complications and HbA1c

Anxiety increased in respondents with type 2 diabetes compared to respondents with type 1 diabetes at Q2 (between-group difference 0.07, $p = 0.024$), Q3 (0.07, $p = 0.025$) and Q4 (0.10, $p = 0.001$) relative to Q1. Respondents with two or more diabetes complications had a larger increase at Q6 relative to Q1 in feelings of social isolation compared to respondents without complications (0.91, $p = 0.014$), a larger increase in diabetes distress at Q5 (0.47, p < 0.001) and a larger decrease in general loneliness at Q4 (−0.641 p < 0.001) Respondents with high HbA1c (>70 mmol/mol / 11.1%) had an increased diabetes-specific loneliness score compared to respondents with low HbA1c at Q5 (between-group difference 0.30, $p < 0.004$) and Q6 (0.28, $p = 0.017$) relative to Q1.

Fig. 2. Trajectories for psychosocial outcomes. Panel A: Trajectories for COVID-19 worries, quality of life and feelings of social isolation (measured with visual analogue scales) with 95% confidence intervals. Panel B: Trajectories for psychological distress, diabetes distress, anxiety, general and diabetes-specific loneliness (measured with questionnaire scales) with 95% confidence intervals.

Table 2
Trajectory coefficients for psychosocial outcomes.

Variables	COVID-19 worries	Quality of life	Feelings of social isolation	Psychological distress	Diabetes distress	Anxiety	General loneliness	Diabetes-specific loneliness
Questionnaire nr.								
1 (March 19)	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
2 (March 26)	−0.084 (0.079)	−0.159** (0.066)	−0.111 (0.086)	−0.095 (0.082)	−0.061** (0.03)	−0.046*** (0.014)	0.098* (0.053)	0.014 (0.035)
3 (April 3)	0.002 (0.082)	−0.259*** (0.069)	0.172* (0.089)	0.021 (0.086)	−0.059* (0.031)	−0.014 (0.015)	0.129** (0.056)	−0.051 (0.036)
4 (April 16)	−0.229*** (0.081)	−0.220** (0.070)	−0.085 (0.091)	0.05 (0.086)	−0.079*** (0.03)	−0.017 (0.015)	0.209*** (0.056)	−0.038 (0.035)
5 (May 20)	−0.762*** (0.085)	-0.005 (0.075)	−0.738*** (0.096)	−0.23** (0.099)	−0.049 (0.034)	−0.054*** (0.017)	−0.069 (0.064)	0.076** (0.036)
6 (June 10)	−1.068*** (0.094)	0.117 (0.087)	−1.234*** (0.105)	−0.578*** (0.11)	−0.069* (0.036)	−0.109*** (0.019)	−0.421*** (0.068)	0.004 (0.043)

Standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. See Supplementary material S3 and S4 for full models as selected by the LASSO algorithm.

4. Discussion

This study documents several changes in psychosocial health in a population of people with diabetes during the first three months of the COVID-19 pandemic in Denmark.

The initial level of psychological distress measured at the beginning of the pandemic in March was relatively low (7.7) compared to reported levels (8.7) in a study of 10,000 respondents from the US general population between March 19–24, 2020 (i.e., the same time as Q1 of this study), using the same distress measure.[25] The proportion of respondents initially feeling isolated did not differ when compared to levels before the pandemic, but a larger than usual proportion of respondents with diabetes felt left out and starved for company.[12,32] Baseline levels of COVID-19 worries, quality of life, and feelings of social isolation were similar to initial levels found in a time-series study of the Danish general population conducted between March 20 and April 16 using similar VAS measures.[24]

COVID-19-specific worries, feelings of social isolation, psychological distress, anxiety, and general loneliness all improved, on average, in mid-May (Q5) compared to the beginning of the pandemic (Q1). The timing of these improvements may be related to reductions in the spread of the COVID-19 virus and the lifting of societal restrictions, as the Danish society began to re-open from May 8 (phase 1) (Fig. 1). The second phase of the re-opening and announcements of further lifting of restrictions in the beginning of June may also have exerted a positive influence on psychological indicators, as COVID-19 worries, feelings of social isolation, psychological distress, anxiety and general loneliness continued to improve.

Studies in the general population in Denmark and in Germany confirm improvements in psychosocial health during the re-opening of society.[24,33] A Danish study found an age and sex-adjusted decrease in COVID-19-specific worries, and an increase in quality of life, between March 20 and April 16.[24] In the same study, feelings of social isolation increased slightly from March 20 to March 26, but then reversed. Comparing these findings to our results indicates that the psychosocial health of people with diabetes might be more affected and for a longer period of time compared to the general population. A study of the general German population, using the same measure of psychological distress as our study, found similar reductions in psychological distress between March 24 and April 21.[33] Other studies conducted in the general population of Germany and Austria between March and June showed that loneliness was low before the pandemic, highest during lock-down, and decreased during re-opening.[34,35] Although this evidence suggests that loneliness during the pandemic was short-lived, an American survey of more than 1000 individuals found that 43% experienced 'high' loneliness in April,[36] which increased by June despite relaxations in societal restrictions.[37] Another study found markedly different levels in loneliness among general populations of the US, South Korea, France and Hong Kong over the course of the pandemic, adding further evidence of country-specific effects on psychosocial health.[38] Although psychosocial health of people with diabetes in our study was comparable to that of the Danish (and other) general populations, this is not necessarily the case in diabetes populations in other countries.[16]

Contrary to the many positive changes in general psychosocial health during the reopening phases, there were no improvements in diabetes-specific psychosocial health at Q6, on average, in the pooled sample. This may be due to the relatively low initial levels of diabetes distress and diabetes-specific loneliness. For example, the level of diabetes distress in the studied population corresponds with what is found in diabetes populations under normal circumstances.[17,18] Whereas this may indicate that the first COVID-19 lockdown in Denmark had little if any impact on diabetes-specific psychosocial health, it may also reflect instead the result of the acute and relatively short lockdown period. That is, the three-month period may not have been enough to spike any real impact, with more general aspects (such as quality of life and loneliness) being more at the forefront of one's psychosocial well-being than diabetes-specific ones. However, a study from the US found that diabetes-related stress increased along with negative impact on diabetes management during the pandemic.[16] These findings were based on participants' self-reported level of stress and worries related to their diabetes when compared to self-reported levels before the pandemic. The same study also reported that half of the participants felt that their diabetes was more difficult to manage during the pandemic than before and the authors link this to the increase in feelings of distress and isolation.[16]

In our study, women had larger decreases in feelings of social isolation, anxiety and psychological distress, and larger increases in quality of life compared to men. Likewise, psychological distress was also higher in women in the aforementioned German study.[33] In our study, women experienced higher levels of anxiety and psychological distress at baseline, as also found in the American survey study,[25] suggesting an initially stronger psychological reaction to the pandemic. However, it cannot be ruled out that women had higher anxiety and psychological distress levels than men already before the pandemic. Adding to this, a Danish study found improvements in psychological well-being in both men and women between the beginning and end of April and attribute this improvement to reduction of symptoms of anxiety and depression.[39]

We also observed larger improvements in psychosocial health for people with a history of mental illness during the study period. This finding can also potentially be attributed to higher baseline levels in this subgroup; however, as noted by Holingue et al., people with preexisting mental illness are more susceptible to psychological distress during pandemics.[40]

Whereas we did not observe statistically significant changes in diabetes-specific psychosocial health in the pooled sample, we observed some interesting changes in diabetes-related subgroups. For instance, respondents with 2+ diabetes complications and those with high HbA1c had increased feelings of social isolation and diabetes-specific loneliness, respectively, compared to those without complications and those with low HbA1c. This suggests that the Danish Health Authority's communication regarding risk factors in people with diabetes may have had an impact on psychosocial health (see Fig. 1).

Strengths of this paper include the relatively large sample size and high retention rate across the study, and the unique and timely survey that was specifically designed to capture aspects of psychosocial health in individuals with diabetes throughout the COVID-19 pandemic. The most important limitation of this study is that data on psychosocial health was not collected in the same population before the pandemic, prohibiting direct before/after comparisons, and requiring that psychosocial health instead be compared to other pre-pandemic studies. Another limitation of this study is that the analyzed population is overrepresented by people of older age, retirees and people living alone, thus limiting the generalizability of the findings. The nature of the questionnaires used to assess diabetes distress and diabetes-specific loneliness may also be limiting. For example, the DDS2 is mainly used in the clinical setting as a screening tool and may not be *as* suitable for research purposes as the full Diabetes Distress Scale. Nevertheless, we chose this and other abbreviated instruments to mediate potential psychological strain on respondents in an already straining situation. Finally, to our knowledge, no longitudinal studies using similar measures have been conducted in people with diabetes, preventing direct comparisons. However, it is also a strength of this study to be among the first to report on this topic, contributing with an extensive analysis that will provide useful in planning support for people with diabetes during the current and future pandemics.

4.1. Conclusions

To conclude, general measures of psychosocial health in people with diabetes improved, on average, during the first three months of the pandemic in Denmark; diabetes-specific measures did not. These findings both confirm and contrast those of other studies. Just as deteriorations in quality of life and increases in loneliness were observed immediately after lockdown, improvements in psychosocial health were observed in relation to reopening phases of society. However, given different trajectories of lockdown and re-openings in different countries, generalization of the presented findings may not be advisable. Nevertheless, our findings highlight the need for attention regarding the impact of the pandemic on psychosocial health, not least for people with chronic illness, and especially in relation to acute effects on loneliness and quality of life. Psychosocial health is highly and rapidly influenced by social restrictions that follow a pandemic, rendering it a crucial task to provide psychosocial support for people with diabetes during sudden and/or prolonged pandemics.

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Declaration of competing interest

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

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