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Association of mental disorders and quality of diabetes care – A six-year follow-up study of type 2 diabetes patients in North Karelia, Finland

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ABSTRACT

Aims: To compare the quality of diabetes care among type 2 diabetes patients with and without mental disorders during six-year follow-up in North Karelia, Finland.
Methods: All type 2 diabetes patients (n = 10190) were analysed using the electronic health records data from 2011–12 to 2015–16. The diabetes care was evaluated using the measurement activity and the achievement of the treatment targets for HbA1c and LDL.
Results: Monitoring of HbA1c and LDL levels improved among all patient groups, except the dementia patients. The proportion of those achieving the HbA1c target declined and those achieving the LDL target improved in all patient groups. Differences in the changes of achievement of the target HbA1c level among patients with dementia and depression were observed when compared with those having only type 2 diabetes.
Conclusions: This study highlights the challenge of glucose level management as the age and comorbidities of the patients related to the care and achievements of the treatment targets. Mental disorders that are likely to affect patients' adherence to medication and other treatments should be taken into account and more support for self-care should be provided to such patients. Improvement in the achievement of LDL target address the progress in the prevention of macrovascular complications.

1. Introduction

Almost 463 million adults are living with diabetes around the world. It is one of the most common and costly chronic health problems worldwide [1]. Comorbidities in type 2 diabetes patients are common and often worsen the quality of care. Type 2 diabetes patients with mental disorders are more likely to have worse quality of diabetes care and thus poorer treatment outcomes [2,3] and more diabetic complications than patients without them [4]. It has been shown that people with diabetes and mental disorder have inadequate adherence to drugs, much less self-care conformity, and more functional

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impairment. This patient behaviour enhances the danger of diabetes-related complications, raises the possibility of very early death and increases healthcare expenses [5,6].

A common mental health illness that has been found to be associated with type 2 diabetes is depression. An increased prevalence of depression among type 2 diabetes patients is well documented. A meta-analysis by Anderson and his colleagues found that the presence of diabetes doubles the chances of having depression [7]. Diabetes along with depression caused poor clinical outcomes [8] and more diabetes-related complications [9]. Depressive patients had low motivation for self-care, which leads to poor physical and psychological conditions. They were also found to use more health care services compared with those without mental disorder [10,11]. The chances of cardiovascular mortality also increased with the combined presence of depression and type 2 diabetes [12,13]. The effect of the coexistence of depression and diabetes was much worse on all-cause and coronary heart disease mortality than when each illness occurred individually [14].

Type 2 diabetes individuals are at risk of suffering from dementia as well. A meta-analysis of prospective observational studies found that type 2 diabetes patients had a 73% greater risk of all types of dementia [15]. Furthermore, a population-based cohort study from Ontario, Canada observed that there was a 16% increased risk of dementia among newly-diagnosed elderly type 2 diabetes patients [16]. A significant predictor of cognitive dysfunction was the presence of type 2 diabetes. The association of type 2 diabetes and cognitive impairment has been researched extensively [17–20]. The main concern of the existence of cognitive impairment in a type 2 diabetes patient was that it affects the self-management and quality of life of the patient [21]. Planning, attention, memory, problem-solving and learning skills were found to be decreased in type 2 diabetes patients with cognitive impairment [22].

Quality of diabetes care among patients with mental disorders has previously been studied internationally. However, there are differences in study populations, designs and settings, which makes it difficult to make conclusions on the effect of mental disorder on the quality of diabetes care [4,23–25]. Some studies have shown poor quality of diabetes care among patients with a mental disorder [11,24,26], while others did not find any disparities [25,27]. A study observing the quality of diabetes care through retrospective analysis of administrative data among patients with and without mental disorder found that type 2 diabetes patients who have a coexistence of mental disorder had more health care visits and had fewer HbA1c and cholesterol measurements. Less than 6% of patients received the recommended care provided by the American Diabetes Association [4].

In Finland, the quality of diabetes care at the national level has been evaluated in few studies [28–30], and information on the quality of diabetes care among type 2 diabetes patients with mental disorder is missing. The aim of this study is to provide long-term information on the quality of diabetes care among type 2 diabetes patients with and without mental disorders, and to compare the quality of care between these patient groups during a six-year follow-up. In order to evaluate the quality of diabetes care, we have used two process of care indicators (HbA1c measurement rate and LDL measurement rate) and two outcome of care indicators (achievement of the target level of HbA1c <7% or 53 mmol/mol and LDL <2.5 mmol/l).

2. Methods

2.1. Study design and setting

This is a retrospective cohort study using data from the regional electronic health records (EHR) of North Karelia, Finland, from 2011 to 2016. In Finland, municipalities are responsible for organising and financing health care and most of the services are public providing inhabitants an equal access to services [31]. In North Karelia, the joint municipal authority organizes both primary and secondary level services for 13 municipalities. A common electronic patient database system called Mediatri is used in health services. The database includes details on patients' age, gender, place of residence, other permanent diagnoses and key laboratory markers, and has been in use since the beginning of 2011 both in primary and specialised care. The ethics approval for the study was received from the Ethics Committee of the Northern Savonia Hospital District on 13 November 2012.

We included data on patients' age, gender, HbA1c and LDL levels, and their permanent diagnosis, such as type 2 diabetes (ICD-10 code E11), dementia (ICD-10 code F00-F03 & G30), depression (ICD-10 code F32-F33) and other mental disorders, such as schizophrenia, mood and neurotic disorders (ICD-10 code F20-F48 except F32-F33) from 2011 to 2016.

2.2. Participants

All patients who had visited a health care centre with the diagnosis of type 2 diabetes were identified from the Mediatri database and were checked by physicians for confirmation of diagnosis. After that, patients who had dementia, depression or other mental disorder along with type 2 diabetes were identified by registered permanent diagnoses in the EHR. At the end of 2012, a total of 10,197 individuals with type 2 diabetes were alive living in the North Karelia region. We included only those aged 20 or older and ended up with a total of 10,190 type 2 diabetes patients at baseline. Among them, 618 had dementia, 771 had depression, 715 had another mental disorder and 8171 had only type 2 diabetes.

During the follow-up, a total of 1761 type 2 diabetes patients died. Of them, 370 had dementia, 130 depression, 118 other mental disorder and 1187 only type 2 diabetes. Therefore, overall a total of 8429 patients were available for the follow-up (age $\geq$ 20) at the end of 2016. However, there was some overlap among the mental disorder patient groups. Some patients had both dementia and other mental disorder (n = 28 in 2011–12; n = 13 in 2015–16) and others had both dementia and depression (n = 57 in 2011–12; n = 28 in 2015–16).

For sensitivity analyses, we also identified patients who had been diagnosed with dementia, depression or other mental disorder during the follow-up. There were 351 new

dementia, 132 new depression and 293 new other mental disorder cases diagnosed.

2.3. Variables

We assessed four measures of quality of care based on the internationally accepted quality of care measurement indicators [32]. Current Finnish care guidelines suggest that the HbA1c level of type 2 diabetes patients should be monitored at least once or twice in a year, and the LDL level should be monitored at least once in a year or every three years depending on the previously achieved control [33]. Therefore, we used HbA1c and LDL testing as process of care indicators during the periods of 2011–12 and 2015–16.

According to Finnish Current care guidelines, the treatment target of HbA1c is <7% or 53 mmol/mol and LDL is <2.5 mmol/l. Therefore, the achievement of the target level of HbA1c (<7% or 53 mmol/mol) and LDL (<2.5 mmol/l) among those whose HbA1c or LDL level was measured both in 2011–12 and 2015–16 were considered as indicators for the outcome of care. Patients who had HbA1c measurements at least three months after (n = 6070) and LDL measurement one month after the diagnosis of type 2 diabetes (n = 5664) were taken into consideration to ensure sufficient time for the treatment to take effect. We categorised HbA1c levels as target met (HbA1c <7% or <53 mmol/mol) and LDL as target met (LDL <2.5 mmol/l) for the descriptive statistics and generalised estimating equation modelling.

Variables for transition plot were categorised as (HbA1c level 20–53 mmol/mol = very good, 53–64 mmol/mol = moder ate, 64–75 mmol/mol = poor and 75–155 mmol/mol = very poor control) and (LDL level 0–1.8 mmol/l = very good, 1.8–2. 5 mmol/l = moderate and 2.5–11 mmol/l = poor control).

2.4. Biochemical methods

HbA1c and LDL samples were analysed in the Eastern Finland Laboratory Centre Joint Authority Enterprise (ISLAB), which is an accredited laboratory and participates in external quality surveys. HbA1c samples were analysed by the turbidimetric inhibition immunoanalysis method (TINIA), and LDL samples were analysed by the photometric direct enzymatic method. All the values were standardised to International Federation of Clinical Chemistry (IFCC) units' levels.

2.5. Statistical method

We used IBM SPSS Statistics for Windows v. 25 for statistical analysis. Counts, percentages and mean values were used to describe the basic characteristics of the patient. Percentages were reported with 95% CI and means for the continuous variables were presented with SD. To assess the differences in the measurement rate and management of HbA1c and LDL among patients with depression, dementia and other mental disorders compared with those who had only type 2 diabetes at the baseline (2011–12), we performed logistic and linear regression models with generalised estimating equations (GEE), as this can account for repeated measurements. Logarithmic transformations were performed only for the skewed independent variable HbA1c before the analysis and LDL levels were normally distributed. Together with unadjusted results, age- and gender-adjusted results are also reported. P-values of less than 0.05 were regarded as statistically significant. Transition plots were used to illustrate the fluctuation of patients HbA1c and LDL levels during the follow-up.

3. Results

Table 1 presents the characteristics of the patients at baseline and follow-up. There were more female patients with dementia, depression and other mental disorder than males, and the mean age of the patients was highest among patients with dementia (Table 1).

The measurement rate of HbA1c improved during the follow-up among all patient groups (from 78–82% to 83–89%) and LDL monitoring also improved among all disease groups (from 74–75% to 83–86%) except the dementia patients (from 53% to 51%) (Table 1). However, when mental disorder patient groups were compared with only type 2 diabetes patients, a significant difference in the changes of the HbA1c measurement rate during the follow-up was observed only among the dementia patient group. A similar trend was observed for the LDL measurement rate (Supplement Table 1).

The highest achievement of the HbA1c target was observed among patients with only type 2 diabetes (72% vs 67% in 2011–12 and 2015–16 respectively) and the achievement of the LDL target was the poorest among patients with depression (50% vs 55% in 2011–12 and 2015–16 respectively) (Table 1).

When we followed the patients whose HbA1c or LDL was measured both at baseline and follow-up, we found variations in outcomes of care indicators. The proportion of those achieving the HbA1c target declined in all groups. When comparing the other patient groups with those having only type 2 diabetes using the age- and gender-adjusted logistic regression model with GEE, a significant difference in changes in the achievement of HbA1c target from baseline to follow-up was observed among dementia and depression patient groups (Table 2).

An improvement in the achievement of the LDL target was observed among all disease groups. Moreover, a significant difference in changes in the achievement of LDL target from baseline to follow-up was observed only among other mental disorder group compared with only type 2 diabetes patients (Other mental disorder: 53% vs 62%; Only type 2 diabetes: 55% vs 62% in 2011–12 and 2015–16 respectively; P = 0.037) (Table 2).

Transition plots were drawn to observe the transition of patients between different HbA1c- and LDL-level categories during the follow-up. We found a considerable number of patients moving from very good HbA1c control to moderate control, and the patterns were similar for all groups (Fig. 1). An opposite trend was observed in LDL control, where more patients were moving towards moderate control from poor control and the patterns were similar for all groups (Fig. 2).

In addition, type 2 diabetes patients who developed mental disorders during the follow-up were analysed separately to observe whether the achievement of treatment target was affected by onset of mental disorders. We found that

Table 1 – Basic characteristics of patients at baseline and follow-up by disorder category.

	Only type 2 diabetes	Dementia	Depression	Other mental disorder
Baseline (2011–12)				
Number of patients, n (%)	8171 (80)	618 (6)	771 (7)	715 (7)
Proportion of females, %	45	62	59	53
Age in years[β], mean (SD)	68 (11.2)	82 (6.57)	63 (13.1)	62 (12.5)
HbA1c measured, % (95% CI)	78 (77–79)	79 (75–82)	78 (75–81)	82 (79–85)
LDL measured, % (95% CI)	75 (74–76)	53 (49–57)	75 (72–78)	74 (71–77)
HbA1c %, mean (SD)[*]	6.63 (1.18)	6.99 (1.30)	6.71 (1.39)	6.65 (1.36)
LDL mmol/l, mean (SD) [**]	2.48 (0.83)	2.47 (0.86)	2.59 (0.88)	2.49 (0.86)
HbA1c <7% or 53 mmol/mol, % (95% CI) [*]	72 (71–74)	60 (55–64)	70 (67–74)	71 (68–75)
LDL <2.5 mmol/l, % (95% CI) [**]	55 (54–56)	55 (50–61)	50 (46–54)	54 (50–58)
Follow-up (2015–16)				
Number of patients, n (%)	6984 (83)	248 (3)	641 (8)	597 (7)
Proportion of females, %	45	66	61	53
Age in years[β], mean (SD)	67 (10.9)	80 (6.78)	61 (12.5)	60 (11.9)
HbA1c measured, % (95% CI)	89 (88–89)	83 (78–88)	89 (86–91)	89 (87–92)
LDL measured, % (95% CI)	86 (85–87)	51 (45–58)	83 (79–85)	86 (83–89)
HbA1c %, mean (SD) [+]	6.84 (1.22)	7.06 (1.31)	6.88 (1.32)	6.80 (1.34)
LDL mmol/l, mean (SD) [++]	2.39 (0.86)	2.18 (0.89)	2.52 (1.01)	2.44 (0.88)
HbA1c <7% or 53 mmol/mol, % (95% CI) [+]	67 (66–69)	54 (47–61)	63 (59–67)	67 (63–71)
LDL <2.5 mmol/l, % (95% CI) [++]	61 (59–62)	69 (60–77)	55 (51–59)	61 (56–65)

Proportion of patient were calculated from total number of patients at baseline (n = 10190) and follow-up (n = 8429) respectively. However, there are overlapping among patient groups.

[β] Age at the end of 2012.

*Patients whose HbA1c was measured at baseline (n = 7988) and **Patients whose LDL was measured at baseline (n = 7485).

+Patients whose HbA1c measured at follow-up (n = 7470) and ++Patients whose LDL measured at follow-up (n = 7128).

the results were almost similar as among the patients who were diagnosed with mental disorder at baseline. The achievement of the HbA1c target declined among all disease groups and the achievement of the LDL target improved (Supplement Table 2).

4. Discussion

This study provided long-term information on the quality of diabetes care among type 2 diabetes patients with and without mental disorders and compared the quality of care between these patient groups. We found that the monitoring of HbA1c and LDL levels improved among all patient groups, except the dementia patients. During the follow-up, the proportion of those achieving the HbA1c target declined and those achieving the LDL target improved in all patient groups.

The results from the previous studies evaluating the process indicators of diabetes care among patients with and without mental disorder have shown inconsistent results. Frayne and his colleagues found that the process of care differs among patients with only type 2 diabetes compared with those with a mental disorder. The odds of having no HbA1c or LDL measurement was respectively 1.24 (1.22–1.27) and 1.25 (1.23–1.28) higher among patients with mental disorder compared with those with no mental disorder [24]. Instead, neither the studies of Krein et al. nor Whyte et al. found any difference in glucose monitoring among patients with only type 2 diabetes compared with the patients with a mental disorder [25,27]. We observed differences in process of care indicators among dementia patients compared with patients with only type 2 diabetes. The results by Cooper et al., describing the processes of care among dementia patients, are also in line with our results. They found that dementia patients are less likely to have primary care visits and annual weight and blood pressure monitoring compared with patients without dementia [34].

It is also observed that patients with dementia find it difficult and confusing to navigate health care services and often end up using emergency services [35]. This could be one possible reason for the observed differences in process of care indicators. Also, dementia patients are older and are more likely to be served by homecare and treated on wards; thus, all follow-up measurements might not have been recorded to the patient records. Also, in reality, the need for active monitoring decreases in very old age. Based on the results, other patient groups seem to have equal access to health care services regardless of their mental disorder. This finding is consistent with earlier studies [25,27].

Previous studies have noted that keeping up with the recommended level of glucose is challenging because of the progressive nature of the disease, and gradual deterioration in β-cell mass and function [36,37]. This might partly explain the HbA1c decline among patient groups. For a better understanding of the results, we drew transition plots which showed that during follow-up, a considerable number of patients were shifting from very good HbA1c levels to moderate levels, irrespective of the underlying mental disorder. This further establishes the fact that maintenance of the recommended glucose level is demanding when the disease is progressing. The population is also ageing and this affects the treatment and its targets. Management of type 2 diabetes in the elderly is more complicated because of the diversity in

Table 2 – Achievement of treatment targets by mental disorder category both at baseline and follow-up.

HbA1c*	Number of patients, n	Age at baseline in years, mean (SD)	Gender females, %	HbA1c <7% or 53 mmol/mol, % (95% CI)		P values		HbA1c %, Mean (SD)		P values	
				Baseline	Follow-up	Unadjusted	Adjusted	Baseline	Follow-up	Unadjusted	Adjusted
Only type 2 diabetes	5016	68 (10.3)	46	75 (73–76)	66 (65–67)			6.58 (1.13)	6.88 (1.22)		
Dementia	169	79 (6.6)	62	64 (56–71)	53 (45–61)	< 0.001	< 0.001	6.85 (1.21)	7.09 (1.29)	< 0.001	0.006
Depression	460	61 (11.7)	62	71 (67–75)	60 (55–65)	0.024	0.013	6.69 (1.35)	7.00 (1.37)	0.202	0.115
Other mental disorder	451	61 (11.4)	55	75 (71–79)	66 (62–70)	0.768	0.865	6.54 (1.27)	6.86 (1.35)	0.209	0.309
LDL**	Number of patients, n	Age at baseline in years, mean (SD)	Gender Females, %	LDL <2.5 mmol/l, % (95%CI)		P values		LDL mmol/l, Mean (SD)		P values	
				Baseline	Follow up	Unadjusted	Adjusted	Baseline	Follow up	Unadjusted	Adjusted
Only type 2 diabetes	4746	67 (10.5)	45	55 (53–56)	62 (61–64)			2.48 (0.81)	2.36 (0.85)		
Dementia	93	78 (7.1)	54	66 (55–75)	67 (56–76)	0.058	0.667	2.28 (0.70)	2.18 (0.86)	0.003	0.200
Depression	424	61 (11.1)	59	49 (44–54)	57 (52–61)	0.005	0.837	2.61 (0.87)	2.48 (0.99)	0.007	0.955
Other mental disorder	415	60 (11.2)	54	53 (48–58)	62 (58–67)	0.661	0.037	2.53 (0.86)	2.41 (0.86)	0.417	0.086

*Patients whose HbA1c was measured both at baseline and follow-up (n = 6070).

**Patients whose LDL was measured both baselines and follow-up (n = 5664).

Unadjusted and adjusted (age and gender) P values from the logistic and linear regression models with GEE for the changes in the achievement of HbA1c and LDL target and changes in the logarithmic transformation of mean HbA1C values and mean LDL values of the patients with dementia, depression and other mental disorder compared with patients having only type 2 diabetes from baseline (2011–12) to follow-up (2015–16).

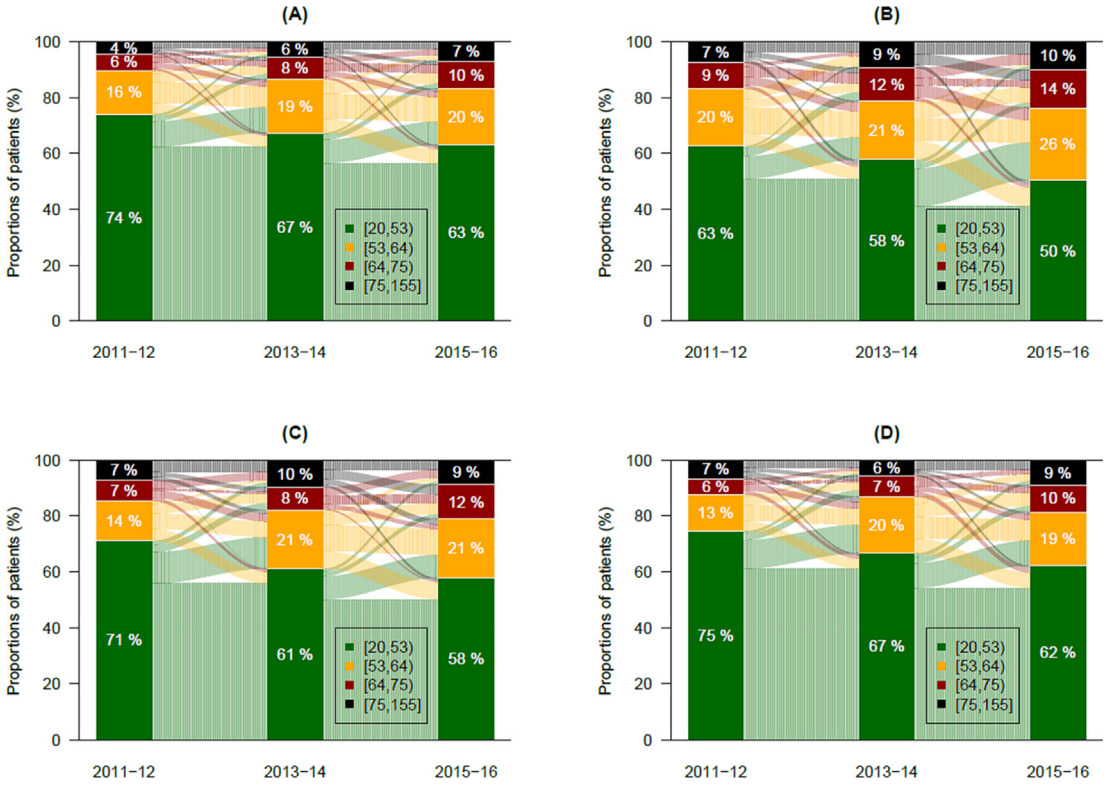

Fig. 1 – Transition of HbA1c levels of type 2 diabetes patient with and without mental disorders at six-year follow-up. (A) Type 2 diabetes patients with no mental disorders (N = 4763, se = 0.3–0.7%), (B) Type 2 diabetes patients with dementia (N = 161; se = 2.0–3.9%), (C) Type 2 diabetes patients with depression (N = 443, se = 1.2–2.3%) and (D) Type 2 diabetes patients with other mental disorder (N = 437, se = 1.1–2.3%).

their clinical, mental and behavioural conditions [38]. Our results emphasise the importance of incorporating individually tailored treatment into routine practice for the management of type 2 diabetes.

This study showed differences in the changes of achievement of the target HbA1c level during follow-up among patients with dementia and depression when compared with those with only type 2 diabetes. Patients with dementia were less likely to achieve the treatment target. Dementia patients are usually older and the primary goals of diabetes management for them include improving quality of life and self-support rather than strict glycaemic control. According to the guidelines, the HbA1c target for elderly patients could be flexible (7.5–8.5% or 58–69 mmol/mol) based on chances of hypoglycaemia and the presence of other complications [33]. Therefore, it is not unexpected to see a difference in HbA1c management in the dementia patient group compared with those having only type 2 diabetes. It is most likely that more individualised targets of glycaemic control have been used for these patients to avoid hypoglycaemia. Another possible reason for the poor achievement of the treatment target among dementia patients could be the non-adherence to the medication. Several studies have identified a relationship between cognitive impairment and poor adherence to the medication. Forgetfulness, insufficient working memory and executive functions in person with cognitive impairment were found to be the reason for poor adherence to the medication [39–41].

Furthermore, we noticed variations in glucose management among depressive patients compared with those having with only type 2 diabetes in our study, which is in agreement with the earlier findings by Frayne et al. and Lustman et al. [8,24]. A possible explanation for this might be that depressive patients have reduced motivation for self-care and reduced commitment to the treatment, leading to poorer treatment outcomes [10,11]. In addition, patients with severe mental illness are often found to have poor quality of diabetes care [3] due to the effect of their medication, which causes weight gain and alters insulin sensitivity and secretion [42]. However, we did not find any difference in the achievement of HbA1c targets during the follow-up among patients from other mental disorder groups compared with those having only type 2 diabetes. One reason for our finding may be the heterogeneity of diagnoses included in the other mental disorders group, as the number of those only having a severe mental illness in our study population was too small to be analysed alone.

Another finding was that during the follow-up, an enormous number of patients with poor LDL level were progressing towards moderate levels and the pattern was similar for all patient groups. According to the guidelines, more attention has recently been paid to the prevention of macrovascular complications. The network of health professionals in North Karelia has also actively developed regional practices in the care of type 2 diabetes patients.

The major strength of this study is that it included a cohort of all diagnosed type 2 diabetes patients living in North

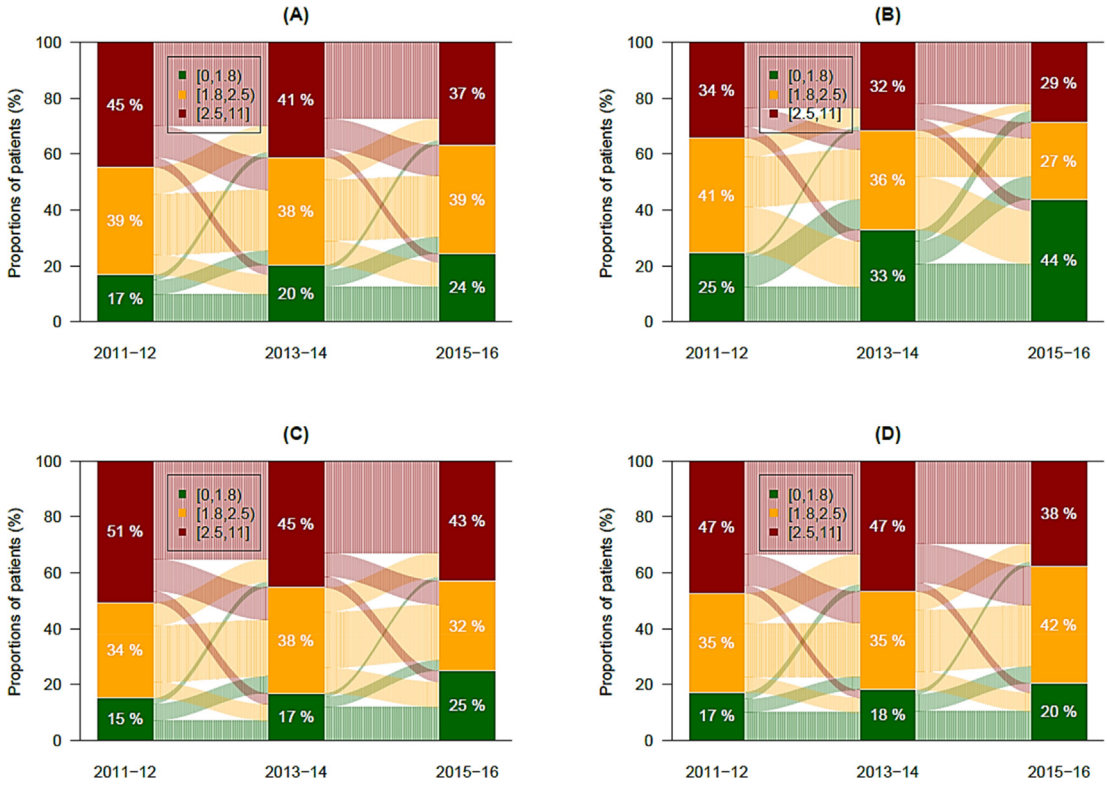

Fig. 2 – Transition of LDL levels of type 2 diabetes patient with and without mental disorders at six-year follow-up. (A) Type 2 diabetes patients with no mental disorders (N = 4437, se = 0.6–0.7%), (B) Type 2 diabetes patients with dementia (N = 73; se = 5.1–5.8%), (C) Type 2 diabetes patients with depression (N = 397, se = 1.8–2.5%) and (D) Type 2 diabetes patients with other mental disorder (N = 393, se = 1.9–2.5%).

Karelia region and provided a six-year long follow-up including information from both primary and secondary level care. Data were collated directly from EHRs of the region and therefore selection bias, non-responsiveness of the patients and missing laboratory data were avoided. Use of the same regional laboratory and standardized methods for HbA1c and LDL measurements ensured the comparability of laboratory data and the results between patients in different municipalities. However, we also have some limitations in our study. Even though most of the patients are treated on public sector there are some who used only private health care services or who did not use the service at all during the follow-up period. This might cause some over or under estimation of achievement of treatment targets. The other limitation is that as the quality of manually entered information in EHRs is not yet optimal, we were not able to use for example information on blood pressure levels.

5. Conclusion

This study highlights the challenge of glucose level management as the age and comorbidities of the patients influence the care and achievements of the treatment targets. The existence of comorbidities such as mental disorders that are often associated for example with patients' adherence to medication and other treatments should be taken into account and more support for self-care should be provided to such patients. The treatment of LDL seems to improve all the time following the current guidelines bringing most likely benefits to the prevention of macrovascular complications.

Author contributions

NN, KW and TL planned the study design. ML compiled the data. NN and ML carried out the statistical analyses. All authors participated in the interpretation of the data and NN drafted the manuscript. TL, KW, JL, PR and HT contributed to the critical revision of the work. All authors read and approved the final version of the manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2020.108312.

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