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# Glycemic control and health-related quality of life among older home-dwelling primary care patients with diabetes



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## ABSTRACT

**Aims:** To evaluate the health-related quality of life (HRQoL) and functional capacity in relation to glycemic control among older home-dwelling primary care patients.

**Methods:** Electronic patient records were used to identify 527 people over 65 years with diabetes. Of these, 259 randomly selected subjects were invited to a health examination and 172 of them attended and provided complete data. The participants were divided into three groups based on the HbA1c: good (HbA1c < 48 mmol/mol (N = 95)), intermediate (HbA1c 48–57 mmol/mol (N = 48)) and poor (HbA1c > 57 mmol/mol (N = 29)) glycemic control. HRQoL was measured with the EuroQol EQ-5D questionnaire. Functional and cognitive capacity and mental well-being were assessed with the Lawton Instrumental Activities of Daily Living (IADL) scale, Mini-Mental State Examination (MMSE) and Geriatric Depression Scale (GDS-15).

**Results:** EQ-5D scores for good, intermediate and poor glycemic control were 0.78; 0.74 and 0.70,  $p=0.037$ . Sub-items of mobility ( $p=0.002$ ) and self-care were the most affected ( $p=0.031$ ). Corresponding trend was found for IADL,  $p=0.008$ . A significant correlation was found between MMSE scores and HbA1c.

**Conclusion:** Older primary care home-dwelling patients with diabetes and poorer glycemic control have lower functional capacity and HRQoL, especially in regard to mobility and self-care.

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## 1. Introduction

Diabetes is a growing health problem worldwide, and especially among older patients diabetes is a major burden. The number of adults with diabetes was estimated to be 422 million globally in 2014 and its prevalence is constantly rising [1]. Treatment of diabetes aims at good glycemic control without hypoglycemia, thereby seeking to prevent micro- and macrovascular complications. Good quality of life is also an important goal of diabetes treatment, especially among older patients [2]. The general HbA1c target in the Finnish diabetes guidelines [3] is <7%, but individually it can be lower (<6.5%) if it can be achieved with simple regimens that do not increase the risk of hypoglycemia, which has to be avoided especially with older patients. The HbA1c target can be 7.5% if there are problems with hypoglycemia [3]. The recent recommendation by the American Association of Clinical Endocrinologists and American College of Endocrinology (AACE) considers an A1C level of  $\leq 6.5\%$  optimal if it can be achieved safely, but higher targets may be appropriate for e.g. older individuals with multimorbidity [4].

Compared with people without diabetes, people with diabetes have poorer health-related quality of life (HRQoL) in general [5] and particularly if they are older patients [6]. HRQoL is affected, for example, by the duration of diabetes [7], co-morbidities [8] and depression [9]. However, study results concerning the relationship between HRQoL and glycemic control are somewhat inconsistent. In some studies, improved glycemic control has been connected with short-term improvement in HRQoL [10]. Not all studies have been able to establish this association [9,11].

Most of the previous studies have focused on a younger diabetic population and little is known about how glycemic control affects the quality of life in older patients with diabetes, although the burden of diabetes increasingly cumulates in older age groups. Therefore, the aim of this study was to evaluate health-related quality of life and functional capacity in relation to glycemic control among older home-dwelling primary care patients.

## 2. Methods

### 2.1. Study population

This cross-sectional study is a part of the Inner-Savo DM65+ study. The basic population (N=3093) was formed from home-dwelling people at least 65 years of age living in the communities of Suonenjoki and Rautalampi in Eastern Finland. People with a diagnosis of diabetes were identified from primary care electronic patient records; they had diagnostic codes E10 and E11 according to the International Classifications of Diseases (ICD-10) [12]. People living permanently in institutional care were excluded from the study group. A health questionnaire was posted to 527 people with diabetes in 2015 and it was answered by 430 (81.6%) of them. Of these persons with diabetes, 259 persons were randomly selected to participate in a health examination. Of these, 180 persons with diabetes attended the health examination conducted by one member of the research group (MK) over a

period of 3.5 months in 2015. The health examination included questionnaires, a clinical investigation and laboratory tests. Complete data were available from 172 patients with diabetes (66% of the invited patients, 33% of the original patient sample based on the electronic patient records). The participants were categorized into three groups based on their HbA1c level according to the Finnish Guidelines [3] and the AACE recommendation [4]. In the good glycemic control group the HbA1c level was less than 48 mmol/mol, in the intermediate glycemic control group it was between 48–57 mmol/mol (6.5–7.4%) and in the poor glycemic control group it was more than 57 mmol/mol (7.4%).

### 2.2. Measurements and tools

Health-related quality of life was measured with the Euro-Qol (EQ-5D) questionnaire [13]. It is a generic measure that includes two parts: a descriptive system and a visual analogue scale (EQ VAS). The descriptive system defines HRQoL in five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. In addition, mental well-being was assessed with the Geriatric Depression Scale (GDS-15) [14]. Higher scores indicate more symptoms. The Lawton Instrumental Activities of Daily Living (IADL) Scale [15] was used to assess the patient's ability to function. Higher IADL scores indicate lower functional capacity. The Mini-Mental State Examination (MMSE) [16] was used to assess cognitive functioning, with higher scores indicating better cognitive functioning.

In the physical examination the patient's state of health was evaluated and measured standardly by a doctor. Blood pressure was measured twice in a sitting position at five-minute intervals after 10 min of rest and average systolic and diastolic pressures were calculated and used as the patient's blood pressure. Body mass index (BMI) was calculated as weight (kg)/height (m<sup>2</sup>). Comorbidities were recorded by the physician according to a list including the most common chronic diseases. The sum of the comorbidities was calculated.

Laboratory tests were done according to the protocol of the Kuopio University Hospital's medical laboratory. All the values are based on fasting samples. Hemoglobin-A1c (b-HbA1c) was measured by turbidimetric inhibition immunoassay with a Cobas 6000 analyzer (Hitachi High Technology, Tokyo, Japan) using Roche Diagnostics reagents (Mannheim, Germany). The reference intervals are 20–42 mmol/mol, corresponding to 4–6% (DCCT/NGSP). The Cobas 6000 analyzer was also used to measure plasma cholesterol, plasma low-density lipoprotein (LDL) cholesterol, plasma high-density-lipoprotein (HDL) cholesterol and triglycerides.

### 2.3. Ethical considerations

All the participants signed an informed consent form. This study was carried out in compliance with the Helsinki Declaration. Ethical permission for the study was granted by the Ethics Committee of the Kuopio University Hospital.

### 2.4. Statistical analysis

Descriptive statistics include means and SDs for continuous variables and numbers and percentages for categorical vari-

**Table 1 – Characteristics of the study subjects in the different HbA1c groups.**

	HbA1c			P-value for linearity
	HbA1c <48 mmol/mol (<6.4%) N = 95	HbA1c 48–57 mmol/mol (6.4–7.5%) N = 48	HbA1c >57 mmol/mol (>7.5%) N = 29	
Men, n(%)	50 (53)	23 (48)	16 (55)	0.98
Age, years				
Mean (SD)	73 (6)	75 (8)	74 (7)	0.31
Range	65–94	65–93	66–93	
Body mass index, kg/m <sup>2</sup>	30.6 (5.4)	31.5 (6.6)	32.1 (6.5)	0.20
Physical activity, Kasari FIT index (SD)	35 (22)	28 (19)	26 (19)	0.28
Able to move without assistive aid, n (%)	75 (80)	34 (71)	19 (66)	0.089
Blood pressure, mean (SD)				
Systolic	155 (21)	148 (22)	148 (26)	0.18
Diastolic	88 (11)	86 (11)	86 (11)	0.40
Average HbA1c in preceding 5 years (SD)				
mmol/mol	44 (6)	50 (4)	66 (12)	<0.001
%	6.2 (0.85)	6.7 (0.549)	8.2 (1.50)	<0.001
P-LDL, mmol/l (SD)	2.77 (0.95)	2.41 (0.92)	2.70 (1.13)	0.76
P-HDL, mmol/l (SD)	1.43 (0.42)	1.34 (0.47)	1.28 (0.38)	0.044
P-Triglycerides, mmol/l (SD)	1.52 (0.69)	1.62 (0.85)	1.66 (0.72)	0.36
Co-morbidities, n (%)				
Heart disease	78 (82)	42 (88)	22 (76)	0.69
Cerebrovascular accident	7 (7)	3 (6)	1 (3)	0.46
Peripheral arterial disease	3 (3)	2 (4)	0 (0)	0.52
Musculoskeletal disorder	34 (36)	22 (46)	12 (41)	0.40
Pulmonary disease	8 (8)	8 (17)	3 (10)	0.46
Cancer	9 (9)	4 (8)	1 (3)	0.34
Neurological disease	5 (5)	1 (2)	1 (3)	0.50
Memory impairment	3 (3)	2 (4)	1 (3)	0.87
Psychiatric disease	6 (6)	1 (2)	0 (0)	0.092
Number of comorbidities	1.61 (0.87)	1.77 (0.78)	1.41 (0.73)	0.21

SD = standard deviation, P-LDL = plasma low-density lipoprotein, P-HDL = plasma high-density lipoprotein, P-Triglycerides = plasma triglycerides.

ables. Statistical significance for the hypothesis of linearity was evaluated using the Cochran-Armitage test and analysis of variance (ANOVA). The relationship (curvilinear correlation) between HbA1c level and functional and mental capacity and health-related quality of life was estimated using regression with a quadratic term. The normality of the variables was tested by using the Shapiro–Wilk W test. In the case of violation of the assumptions (e.g. non-normality), a bootstrap-type test was used. The STATA 14.0 statistical software package (Stata Corp, College Station, TX) was used for all analyses.

### 3. Results

Complete data were available from 172 participants. The good glycemic control group (HbA1c level <48 mmol/mol/6.5%) included 95 patients, the intermediate glycemic control group (HbA1c level, between 48–57 mmol/mol/6.5–7.4%) had 48 patients and the poor glycemic control group (HbA1c level >57 mmol/mol/7.4%), 29 patients.

The characteristics of the study population are shown in [Table 1](#). Mean age was similar in all groups. There was no statistically significant difference between the different HbA1c groups where BMI, blood pressure and co-morbidities were

concerned. Lower HDL levels were connected to poorer HbA1c levels ( $1.43 \pm 0.42$  in patients with good and  $1.28 \pm 0.38$  in patients with poor glycemic control), but there were no differences in LDL and triglyceride levels between groups.

The average HbA1c level in the preceding 5 years was 44 mmol/mol (6.2%) in the good glycemic control group, 50 mmol/mol (6.7%) in the intermediate glycemic control group and 66 mmol/mol (8.2%) in the poor glycemic control group. The difference between groups was statistically significant ( $p < 0.001$ ).

Oral diabetes medication (without insulin) was used by 85.3% of the patients with good, 70.8% with intermediate and 37.9% with poor glycemic control. Insulin (without oral insulin medication) was used by 2.1% with good, 4.2% with intermediate and 20.7% with poor glycemic control. Of the patients with poor glycemic control, 34.5% had both insulin and oral medication for diabetes; the corresponding percentages were 14.6% with intermediate and 5.3% with good glycemic control.

Health-related quality of life was significantly lower in patients with poorer glycemic control ( $0.781 \pm 0.157$  with good,  $0.743 \pm 0.174$  with intermediate and  $0.702 \pm 0.181$  with poor glycemic control). These results were statistically significant even after adjusting for age, gender and number of comorbidities ([Table 2](#)). The results concerning different parts of the

**Table 2 – Physical and mental capacity and health-related quality of life in the different glycaemic control groups.**

	HbA1C			P-value for linearity	
	<48 mmol/mol (<6.4%) N = 98	48–57 mmol/mol (6.4–7.5%) N = 48	>57 mmol/mol (>7.5%) N = 29	Crude	Adjusted <sup>a</sup>
IADL, mean (SD)	9.6 (2.8)	10.4 (4.2)	12.5 (6.2)	0.014	0.0083
MMSE, mean (SD)	27.4 (2.5)	27.1 (2.8)	25.6 (5.6)	0.089	0.085
GDS15, mean (SD)	3.4 (3.2)	3.6 (3.6)	3.2 (3.0)	0.86	0.92
EQ5D	0.781 (0.157)	0.743 (0.174)	0.702 (0.181)	0.046	0.037
No problems in sub-items, n (%)					
Mobility	41 (46)	14 (30)	3 (12)	<0.001	0.002
Self-care	82 (91)	40 (87)	17 (68)	0.006	0.031
Usual activities	70 (78)	37 (80)	13 (52)	0.038	0.097
Pain/discomfort	27 (30)	11 (24)	9 (36)	0.82	0.62
Anxiety/depression	80 (89)	40 (87)	24 (96)	0.46	0.34

SD = standard deviation.

IADL = Lawton Instrumental Activities of Daily Living Scale.

MMSE = Mini-Mental State Examination.

GDS15 = Geriatric Depression Scale.

EQ5D = EuroQol Questionnaire.

<sup>a</sup> Age, gender, number of comorbidities.

EQ-5D questionnaire show that patients with poorer glycaemic control had more problems in mobility (46% in the good, 30% in the intermediate and 12% in the poor glycaemic control group had no problems,  $p < 0.005$ ), self-care (91% in the good, 87% in the intermediate and 68% in the poor glycaemic control group had no problems,  $p = 0.006$ ) and usual activities (78% in the good, 80% in the intermediate and 52% in the poor glycaemic control group had no problems,  $p = 0.038$ ). After adjusting for age, gender and number of comorbidities, only the results concerning mobility and self-care remained statistically significant. With regard to pain/discomfort, usual activities and anxiety/depression, there were no statistically significant differences between the groups.

Higher IADL scores were associated with poor glycaemic control ( $9.6 \pm 2.8$  with good,  $10.4 \pm 4.2$  with intermediate and  $12.5 \pm 6.2$  with poor glycaemic control) and these results were statistically significant even after adjusting for age, gender and number of comorbidities. There were no statistically significant differences in the MMSE and depressive symptoms (GDS-15) scores between groups, although there was a non-significant trend of decreasing MMSE scores.

Fig. 1 shows the curvilinear correlations between HbA1c level and health-related quality of life and functional and mental capacity. The results indicate that higher HbA1c levels were statistically significantly associated with poorer HRQoL ( $r = 0.16$ , 95% CI 0.01–0.31). There was also an association between both higher IADL ( $r = 0.22$ , 95% CI 0.07–0.36) and lower MMSE scores ( $r = 0.25$ , 95% CI: 0.11–0.39) and poorer glycaemic control. With regard to depressive symptoms there was no statistically significant difference ( $r = 0.02$ , 95% CI:  $-0.13$  to  $0.17$ ).

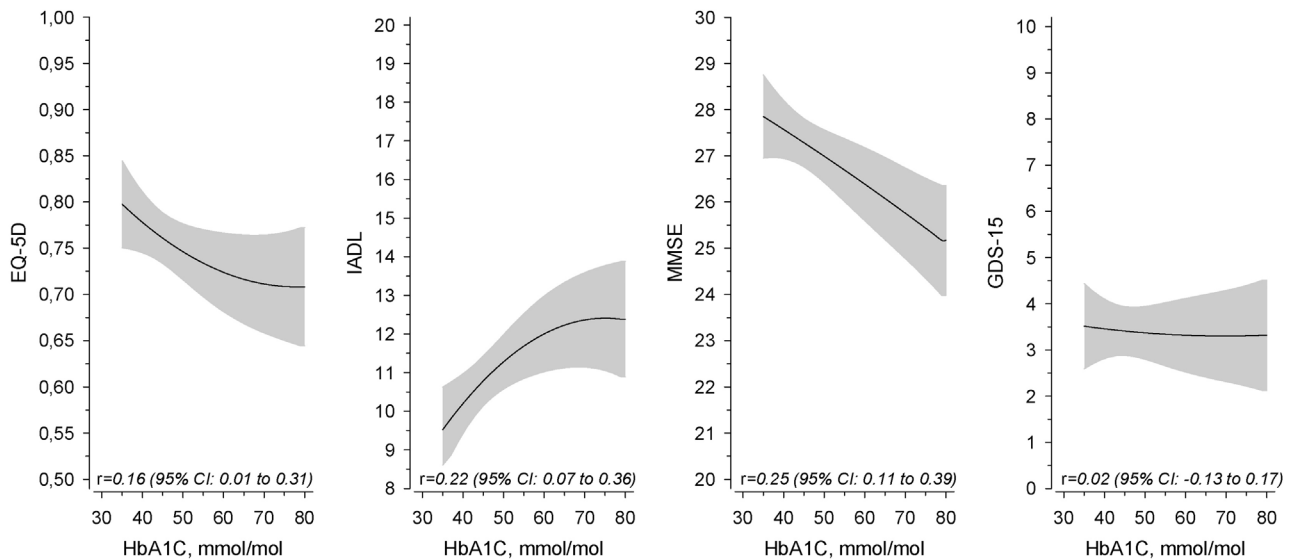
#### 4. Discussion

These results indicate that older primary care patients with diabetes and poorer glycaemic control have lower health-related quality of life, especially with regard to mobility and self-care. Furthermore, the present study suggests that increased HbA1c levels are associated with declining cogni-

tion and functional capacity. Previously, there have not been many studies concerning the relationship between glycaemic control and quality of life or functional capacity, particularly in older patients with diabetes.

The findings of the present study are in line with two previous studies, where quality of life was measured by SF-36 [17,18]. In the WESDR study, Klein and Klein [17] showed that higher HbA1c levels are related to poorer quality of life (QoL). The main interest in that study was, however, in diabetic complications, which the study group suggested caused most of the lowering of the QoL. In a Malaysian study, Kamarul et al. [18] compared patients with type 2 diabetes and HbA1c levels below and above 7.5%. They found that patients with higher HbA1c levels had lower SF-36 scores. However, not all studies have been able to confirm similar connections [19]. Kleefstra et al. found [20] that HRQoL was associated with hyperglycaemic symptoms but not with HbA1c level in primary healthcare patients. In a Swedish study, Wändell et al. assessed the HRQoL of older patients with diabetes. They showed that cognitive functioning was the only part of the SWED-QUOL that was associated with glycaemic control [21].

The present study did not find any significant connection between glycaemic control and depressive symptoms. This finding is contrary to a previous finding suggesting that there is a connection between depression and HbA1c levels [22]. However, another study with older people suggested that HbA1c levels and depression are not associated [23]. Previously, the burden of diseases has been found to explain the increased level of depressive symptoms in people with diabetes [24], although that finding could be explained by long-term impaired glucose regulation. However, in the present study, HbA1C levels were not associated with the number of chronic diseases. Contrary to the findings regarding depressive symptoms, we found that patients with higher HbA1c levels may have lower cognitive capacity. This finding is in line with a primary care setting study indicating that HbA1c levels  $\geq 7\%$  are associated with a risk of Alzheimer's disease [25]. Therefore, it can be assumed that good glycaemic control



EQ-5D=EuroQol Questionnaire  
 IADL= Lawton Instrumental activities of Daily living Scale  
 MMSE=Mini-Mental State Examination  
 GDS-15=Geriatric Depression Scale

**Fig. 1 – Crude relationship between Hba1c level and functional and mental capacity and health-related quality of life. Curvilinear correlations with 95% confidence intervals were estimated using quadratic relationships. EQ-5D = EuroQol Questionnaire, IADL = Lawton Instrumental Activities of Daily Living Scale, MMSE = Mini-Mental State Examination., GDS-15 = Geriatric Depression Scale.**

is important in preventing cognitive decline in older people with diabetes.

Previous studies have shown that type 2 diabetes is associated with co-morbidities [5], which in turn have a great impact on HRQoL [8]. Surprisingly, in the present study there was no statistically significant difference between the different HbA1c groups where co-morbidities were concerned. Thus, the results of this study suggest that glycemic control affects HRQoL regardless of co-morbidities, although the co-morbidities still may have an influence on HRQoL in people with diabetes.

This study has some limitations. First, the study was cross-sectional in nature. It is not known where the difference in HRQoL between different HbA1c levels comes from. It can be caused, for example, by a failure of treatment. Also, it is not possible to say if lower HRQoL is caused by poor HbA1c levels or if there are some other connecting factors. One explanation could be the need for insulin in the treatment of diabetes, which may be related to worse QoL and functional capacity. However, the trend of decreasing QoL and functional capacity was also found with lower HbA1c levels, representing patients that use insulin less often. We were not able to define the onset of diabetes precisely. However, the mean HbA1c values representing glycemic control in the preceding five years were in line with the cross-sectional HbA1c values in these three groups. Therefore, we can assume that these values represent the long-term treatment situation. Although the patients in our study represented home-dwelling individuals, some of

them may have been frail with higher target levels for HbA1c than less frail individuals. The set target levels may influence the observed levels. Therefore, a potential limitation is that we were not able to know the target HbA1c level of individual patients.

The strengths of the present study include the fact that the examined patients were selected from a population representing older people with diabetes in primary care. In addition to categorized HbA1c levels we were able to conduct an analysis that explored the relationship between HbA1c and various QoL and functional capacity measures using continuous variables. Validated measurements were used in the present study. However, in future projects, in addition to general QoL and functional capacity, measurements of diabetes-related distress should be used in order to compare the results from different populations and patients. The Problem Areas in Diabetes (PAID) questionnaire is an option for this purpose [26].

The recent large population study showed that higher HbA1c levels are associated with increased mortality in older adults [27]. Previously it has been recommended that the target levels of HbA1c in older patients should be 7.0-7.5% [28]. This is supported by this present primary care setting study which emphasizes good glycemic control also in older people with diabetes when targeting good quality of life and both physical and cognitive functional capacity. In primary care clinical practice, the treatment goals of diabetes should include good glycemic control with individual target levels. Maybe in the future lower target levels could be applied also

to older patients, especially if safer treatment options with a low risk of hypoglycemia could be used in most of the older patients with diabetes. In general, sustaining and restoring individual patients' quality of life and functional capacity should be the most important goals. Therefore, assessment of these dimensions of health should be implemented in clinical practice in addition to traditional clinical measures.

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## Conflict of interest

The authors state that they have no conflict of interest.

## REFERENCES

- [1] WHO, Global Report on Diabetes, 2016. [http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf). (last Accessed 15 January 2017).
- [2] R.A. Oliveira, M. Tostes, V.A. Queiroz, et al., Insulin mediated improvement in glycemic control in elderly with type 2 diabetes mellitus can improve depressive symptoms and does not seem to impair health-related quality of life, *Diabetol. Metab. Syndr.* 7 (2015) 55.
- [3] Diabetes (online), Current Care Guidelines. Working Group Set up by the Finnish Medical Society Duodecim, the Finnish Association for the Internal Medicine and the Medical Council of the Finnish Diabetes Association, The Finnish Medical Society Duodecim, Helsinki, 2016, [www.kaypahoito.fi](http://www.kaypahoito.fi). (last Accessed 26 June 2016). (in Finnish).
- [4] A.J. Garber, M.J. Abrahamson, J.I. Barzilay, et al., Consensus statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the comprehensive type 2 diabetes management algorithm—2016 executive summary, *Endocr. Pract.* 22 (2016) 84–113.
- [5] R.R. Rubin, M. Peyrot, Quality of life and diabetes, *Diabetes Metab. Res. Rev.* 15 (1999) 205–218.
- [6] D.W. Brown, L.S. Balluz, W.H. Giles, et al., Diabetes mellitus and health-related quality of life among older adults. Findings from the behavioral risk factor surveillance system (BRFSS), *Diabetes Res. Clin. Pract.* 65 (2004) 105–115.
- [7] M. Peyrot, R.R. Rubin, Levels and risks of depression and anxiety symptomatology among diabetic adults, *Diabetes Care* 20 (1997) 585–590.
- [8] D.J. Wexler, R.W. Grant, E. Wittenberg, et al., Correlates of health-related quality of life in type 2 diabetes, *Diabetologia* 49 (2006) 1489–1497.
- [9] J. Wasem, P. Bramlage, A. Gitt, et al., Co-morbidity but not dysglycaemia reduces quality of life in patients with type-2 diabetes treated with oral mono- or dual combination therapy—an analysis of the DiaRegis registry, *Cardiovasc. Diabetol.* 12 (2013) 47.
- [10] M.A. Testa, D.C. Simonson, Health economic benefits and quality of life during improved glycemic control in patients with type 2 diabetes mellitus: a randomized, controlled, double-blind trial, *JAMA* 280 (1998) 1490–1496.
- [11] R.T. Anderson, K.M. Narayan, P. Feeney, et al., Effect of intensive glycemic lowering on health-related quality of life in type 2 diabetes, *Diabetes Care* 34 (2011) 807–812.
- [12] WHO, The International Classification of Diseases (ICD-10) diagnostic codes. <http://www.who.int/classifications/icd/en>. (last Accessed 15 January 2017).
- [13] EuroQol Group, EuroQol—a new faculty for the measurement of health-related quality of life, *Health Policy* 16 (1990) 199–208.
- [14] J.I. Sheikh, J.A. Yesavage, Geriatric depression scale (GDS). Recent evidence and development of a shorter version, *Clin. Gerontol.* 5 (1986) 165–173.
- [15] M.P. Lawton, E.M. Brody, Assessment of older people: self-maintaining and instrumental activities of daily living, *Gerontologist* 9 (1968) 179–186.
- [16] M.F. Folstein, S.E. Folstein, P.R. McHugh, “Mini-mental state”; a practical method for grading the cognitive state of patients for the clinician, *J. Psychiatr. Res.* 12 (1975) 189–198.
- [17] R. Klein, B. Klein, Relation of glycemic control to diabetic complications and health outcomes, *Diabetes Care* 21 (Suppl. 3) (1998) C39–C43.
- [18] I.M. Kamarul, A. Ismail, L. Naing, W.B. Wan Mohamad, Type 2 diabetes mellitus patients with poor glycemic control have lower quality of life scores as measured by the short form-36, *Singap. Med. J.* 51 (2010) 157–162.
- [19] M. Weinberger, M.S. Kirkman, G.P. Samsa, et al., The relationship between glycemic control and health-related quality of life in patients with non-insulin-dependent diabetes mellitus, *Med. Care* 32 (1994) 1173–1181.
- [20] N. Kleefstra, L.J. Ubink-Veltmaat, S.T. Houweling, et al., Cross-sectional relationship between glycemic control, hyperglycemic symptoms and quality of life in type 2 diabetes (ZODIAC-2), *J. Med.* 63 (2005) 215–221.
- [21] P.E. Wändell, J. Tovi, The quality of life of elderly diabetic patients, *J. Diabetes Complicat.* 14 (2000) 25–30.
- [22] N. Schmitz, S. Deschenêz, R. Burns, K.J. Smith, Depressive symptoms and glycated hemoglobin A1c: a reciprocal relationship in a prospective cohort study, *Psychol. Med.* 46 (2016) 945–955.
- [23] P. Palta, S.H. Golden, J.A. Teresi, et al., Depression is not associated with diabetes control in minority elderly, *J. Diabetes Complicat.* 28 (2014) 798–804.
- [24] P. Mäntyselkä, K. Korniloff, T. Saaristo, et al., Association of depressive symptoms with impaired glucose regulation, screen detected, and previously known type 2 diabetes. Findings from the Finnish D2D survey, *Diabetes Care* 34 (2011) 71–76.
- [25] A. Ramirez, S. Wolfsgrubera, C. Lange, et al., Elevated HbA1c is associated with increased risk of incident dementia on primary care, *J. Alzheimer's Dis.* 44 (2015) 1203–1212.
- [26] W.H. Polonsky, B.J. Anderson, P.A. Lohrer, et al., Assessment of diabetes-related distress, *Diabetes Care* 18 (1995) 754–760.
- [27] P. Palta, E.S. Huang, R.R. Kalyani, et al., Hemoglobin A1c and mortality in older adults with and without diabetes: results from the National Health and Nutrition Examination Surveys (1988–2011), *Diabetes Care* 40 (2017) 453–460.
- [28] C. Tsigos, R. Bitzur, Y. Kleinman, et al., Targets for body fat, blood pressure, lipids, and glucose-lowering interventions in healthy older people, *Diabetes Care* 36 (2013) S292–S300.