

Metabolic factors that affect health-related quality of life in type 2 diabetes patients: a multivariate regression analysis

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Purpose: In the past few decades, an increase in the life span of the population has caused more people to experience chronic diseases, such as type 2 diabetes. Since chronic diseases influence the whole life of patients and do not have a specific remedy, improving their health-related quality of life (HRQoL) becomes more important. The aim of the present study was to investigate the metabolic variables that influenced HRQoL questionnaire scores most significantly among patients with type 2 diabetes.

Patients and methods: The population of this cross-sectional study included 163 patients with type 2 diabetes and 214 healthy people who were asked to complete the HRQoL questionnaire, and their metabolic blood variables were recorded simultaneously. The effects of metabolic variables and some other demographic ones on two main scales of HRQoL, Mental Component Summary (MCS) and Physical Component Summary (PCS), were evaluated using multivariate regression.

Results: Multivariate regression analysis showed that PCS score was most negatively influenced by cigarette smoking ($P=0.009$, $\beta=-15.761$), maximum blood pressure ($P=0.008$, $\beta=-0.108$), minimum blood pressure ($P=0.009$, $\beta=-0.039$), low-density lipoprotein cholesterol ($P=0.008$, $\beta=-0.721$), cholesterol ($P=0.006$, $\beta=-0.648$), HbA1c ($P=0.004$, $\beta=-0.878$), FBS ($p=0.006$, $\beta=-0.769$), and body mass index (BMI) ($P=0.034$, $\beta=-0.287$). The MCS score was influenced positively by smoking cigarettes ($P=0.041$, $\beta=13.032$), gender ($P=0.018$, $\beta=15.633$), and BMI ($P=0.048$, $\beta=-0.088$). Men had a higher MCS score compared to women.

Conclusion: The HRQoL questionnaire (as a concept of health) score could be improved by controlling the variation of some metabolic variables in patients with type 2 diabetes. Some metabolic variables could be the main causes of a decrease in physical and mental HRQoL among patients with type 2 diabetes.

Keywords: quality of life, SF-36 questionnaire, metabolic variables

Introduction

Type 2 diabetes is one of the most serious chronic diseases with complex complications and treatment, and the majority of patients have depression symptoms.¹ Type 2 diabetes has achieved epidemic levels in most countries and epidemiologic studies have indicated that without efficient prevention and control programs, its prevalence will continue to rise globally.² It is estimated that there were 366 million people with diabetes in 2011, and that will increase to more than 552 million in 2030.³ In Iran, as in other developing countries, the number of people with type 2 diabetes is increasing due to the change in lifestyle. The prevalence of type 2 diabetes in Iran was 5.5% in 2008.⁴

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Patients with diabetes have to manage their level of blood glucose by controlling nutrition and using difficult treatment. Living with a controlled daily schedule leads to chronic stress among these patients.⁵

Health-related quality of life (HRQoL) is defined as a multifactorial concept that shows physical, mental, and social functioning in a person's life that may be affected by disease.⁶ Researchers have shown that, physicians' evaluation of health may not be in accordance with patients' understanding of health.⁷

According to the WHO, the conventional concept of health, which means the absence of disease, should be reviewed.⁸ Therefore, HRQoL can be considered as a main health outcome and represents the result of therapeutic interventions in the best manner.⁹

Specific diet and medication dependency in diabetic patients^{10,11} decrease their HRQoL level.¹² Previous studies have confirmed that the HRQoL of patients with type 2 diabetes is lower than the HRQoL of general people.^{6,13,14} A higher body mass index (BMI) ($\text{BMI} \geq 30 \text{ kg/m}^2$),¹⁵⁻¹⁸ old age,^{19,20} gender (particularly women), and having hypertension as a concomitant disease⁹ could be the main causes of low HRQoL among patients with diabetes.

The HRQoL concept is usually evaluated with a special questionnaire. The Short Form (36) Health Survey (SF-36) is a famous questionnaire for evaluating HRQoL in different types of disease.

The SF-36 is a 36-item questionnaire consisting of eight domains, and also two summarized main scales which are called Physical Component Summary (PCS) and Mental Component Summary (MCS).^{21,22} These two scales categorize the HRQoL concept into two main concepts, physical and mental HRQoL. Using these two scales instead of eight domain scores leads to the simplest analysis and interpretation of the HRQoL concept. Many studies have shown the role of HRQoL in the life of patients with type 2 diabetes, but the relation between HRQoL (as a concept of health) and metabolic variables (as clinical measurements) has rarely been reported. The aim of this study was to first compare the HRQoL score between patients with type 2 diabetes and healthy people, and second, to determine the effect of metabolic variables and some demographic factors on PCS and MCS scales of patients with type 2 diabetes using multivariate regression.

Materials and methods

In total, 163 patients with type 2 diabetes were recruited from May to October 2018 (143 women and 20 men).

These patients were referred to Besat Laboratory for blood tests by an endocrinologist. Besat laboratory is the main laboratory for diabetes in Kerman (southern Iran). Participants under the age of 18 and pregnant women, as well as patients with other chronic diseases (type 1 diabetes, not having severe kidney disorders) were excluded from the study (eight patients). For comparison, 214 healthy people (147 women and 67 men), with no chronic diseases for at least 1 year, who had been coming to Besat laboratory for annual check-ups, were enrolled. Some of them may have used drugs for enjoyment (like a habit), but they did not have type 2 diabetes or any other chronic disease. The participants of this study completed informed consent forms before enrollment. They were asked to answer the SF-36 questionnaire in a quiet room and their minimum and maximum blood pressure (BP) was measured by a skilled nurse. BP was measured using a BP cuff in a seated position twice (first, on the blood test day and the second on the next day, when they came in to get their test result). The average of two BP measurements was recorded as BP value. They also answered questions about their personal characteristics that may have an effect on their HRQoL, such as smoking status, use of drugs, BMI, and level of education. The demographic variables were also recorded. After a night of fasting, 5 mL blood sample was taken from each person. After the formation of the clot, the serum was separated from the blood sample, and serum FBS, TG, total cholesterol, high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) levels were measured by BS-300 MINDRAY (Shenzhen Mindray Bio-medical Electronics Co., China) by Roche kits (Germany). HbA1c was measured by Enzymatic method (Selectra, Iran). For quality control purpose, TruCal HDL/LDL, Lot: 326007 was used to calibrate the biochemical tests and TruLab N, P Lot: 11483 and TruLab Lipid, Lot: 10502 were applied to check the accuracy of biochemical tests. To control the quality of HbA1c tests, Control Serum, Lot: 304687 was used. The study was approved by the ethics committee of Kerman University of Medical Sciences (reference number: IR.KMU.REC.1397.174). This study was conducted in accordance with the Helsinki Declaration of 1964.

The SF-36 questionnaire was used as a health survey instrument in order to evaluate HRQoL of the patients in the study. This questionnaire has eight main domains, including: physical function (PF, ten items), role physical (RP, four items), role emotional (RE, three items), social function (SF, two items), bodily pain (BP, two items), mental health (MH,

five items), vitality (VT, four items), and general health (GH, five items) perceptions, and two summary scales, PCS and MCS, which are produced by factor analysis of eight domain scores. In the second version, four domains, including PF, RP, BP, and GH are highly correlated with the physical component and contribute to scoring the PCS and also four domains, including MH, RE, SF, and VT are highly correlated with the mental components which contribute to scoring the MCS measure. In fact, eight domains were summarized in two main scales. Each raw domain score has equal weight between 0–100 scores, and higher scores denote better health status in all dimensions. The SF-36 that was used in this study had previously been translated into Persian, and its reliability and validity have been defined in a previous study in Iran.²¹

Multivariate regression was used when the effect of some variables on more than one outcome variable was evaluated. Multivariate regression was used in order to assess the effect of some metabolic and demographic variables on MCS and PCS as a vector of outcomes. The Shapiro-Wilk test was used in order to check normality of continuous variables. The Wilks' Lambda and Pillai's trace were used for checking the overall test in multivariate multiple regression. For statistical assessment, SPSS version 20 was used. A value of $P < 0.05$ was considered as statistically significant.

Results

The subject characteristics in patients and healthy groups are summarized in Table 1. As it was observed in both groups, the number of women were significantly more than men ($P < 0.001$). It may be due to the fact that women usually care more about their health. There were no significant differences between patient and healthy groups in smoking status ($P = 0.199$) and use of drugs ($P = 0.509$), but in terms of education level, patient group had a significantly higher education level ($P < 0.001$). There was a statistically significant difference in mean of age between the two groups ($P < 0.001$). The patient group was older. The average BMI in the patient group was significantly higher than in the healthy group ($P = 0.019$).

The comparison of BP and metabolic variables between patient and healthy groups is shown at the bottom of Table 1. As shown, there were statistically significant differences in the mean of maximum BP ($P = 0.001$), minimum BP ($P < 0.001$), HDL-C ($P = 0.004$), LDL-C ($P = 0.012$), and HbA1c ($P < 0.001$) between patient and healthy groups. The patient group had higher mean values for all of them. Triglycerides ($P = 0.124$) and total cholesterol ($P = 0.426$) were not significant between groups.

There were statistically significant differences in mean FBS and HbA1c between the two groups ($P < 0.001$), and the patient group had higher values in both compared to the healthy group.

Table 2 presents a comparison of HRQoL between type 2 diabetes patients and healthy people on eight domains and two summary scales of the SF-36 questionnaire. The scores of all domains showed the worse scores for type 2 patients, and MH ($P = 0.028$), PF ($P = 0.039$), and GH ($P = 0.02$) domain scores were significantly lower in the patient group. The MCS ($P < 0.001$) and PCS ($P = 0.018$) scores were also significant between them.

The effect of characteristics and metabolic variables on MCS and PCS scales of SF-36 questionnaire is presented in Table 3. The results of the multivariate regression analysis revealed that PCS was negatively influenced by cigarette smoking ($P = 0.009$, $\beta = -15.761$), BMI ($P = 0.034$, $\beta = 0.287$), maximum BP ($P = 0.008$, $\beta = -0.108$), minimum BP ($P = 0.009$, $\beta = -0.039$), LDL-C ($P = 0.008$, $\beta = -0.721$), Chol ($P = 0.006$, $\beta = -0.648$), HbA1c ($P = 0.002$, $\beta = -0.878$), and FBS ($P = 0.006$, $\beta = -0.769$). The lower the educational level (diploma), the more significant the negative effect on PCS score ($P = 0.046$, $\beta = -10.328$).

None of the metabolic variables had a significant effect on MCS score. The MCS score was influenced positively by smoking cigarettes ($P = 0.041$, $\beta = 13.032$) and gender ($P = 0.018$, $\beta = 15.633$). Men had a higher MCS score compared to women. BMI had a significant negative effect on the MCS score ($P = 0.048$). The educational level had a significant effect on the MCS scale score. The higher the degree of education, the higher the MCS score.

Discussion

Today, assessment of quality of life is used as an important factor in the evaluation of health care outcomes. In the present research, the effects of metabolic variables that are reported routinely in blood tests on MCS and PCS scales have been studied. The pure effects of each metabolic variable on MCS and PCS scales revealed new insights regarding the relationship between clinical factors and HRQoL among patients with diabetes. In this study, most metabolic variables such as LDL-C, total cholesterol, and BP had a significant negative effect on PCS in type 2 diabetes patients. As another study showed similar negative associations between blood lipid index, BP, and HRQoL in patients with diabetes in Iran,²³ and also in accordance with the result of Kontodimopoulos et al's work that confirmed the negative effect of high BP and higher lipidemia on GH

Table 1 Subject characteristics of healthy people and type 2 diabetes patient groups

	Healthy people N=214	Type 2 diabetes patients N=163	P-value
Smoking, number (%)			
Yes	15(7)	18(11)	0.199
No	199(93)	145(89)	
Drug use, number (%)			
Yes	4(1.9)	5(3.1)	0.509
No	210(98.1)	158(96.9)	
Gender, number (%)			
Women	147(68.7)	143(87.7)	<0.001**
Men	67(31.1)	20(12.3)	
Education level, number (%)			
Diploma	16(7.5)	0	<0.001**
Associate Degree	26(12.1)	6(3.7)	
Bachelor	87(40.7)	25(15.3)	
MS	57(26.6)	61(37.4)	
Ph.D.	28(13.1)	71(43.6)	
Age, mean ± SD	39.04±13.42	47.93±12.81	<0.001**
BMI, mean ± SD	28.14±4.2	29.42±6.3	0.019**
Blood Pressure, mean ± SD			
Minimum	85.17±11.65	91.28±9.89	<0.001**
Maximum	133.32±18.96	142.03±27.38	<0.001**
Metabolic variables, mean ± SD			
Chol	169.5±37.56	166.56±32.52	0.426
TG	124.13±71.60	136.18±77.80	0.124
HDL_C	48.77±12.74	53.26±16.45	0.004**
LDL_C	109.5±33.88	100.74±33.10	0.012**
FBS	95.36±10.93	189.94±64.55	<0.001**
HbA1c	5.439±0.628	8.504±2.735	<0.001**

Notes: **P-value <0.05 is significant.

Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL-C cholesterol; Chol, High-density lipoprotein cholesterol; HbA1c, Hemoglobin A1c; BMI, Body Mass Index; TG, Triglycerides.

domain score,¹⁹ the results of the present study are acceptable. The present study showed a significant negative association between HbA1c and FBS levels on the PCS score. It is similar to the result of Dogan et al, that showed a negative correlation between HbA1c levels and PCS and MCS scores,⁹ but in contrast with the result of Simmons et al, that showed that PCS and MCS were not significantly associated with HbA1c in multivariable analysis.²⁴ The result of a study on diabetic patients with foot ulcers showed that there was a significant negative correlation between fasting blood sugar and quality of life,²⁵ and it is similar to the result of the current study.

In investigating the effect of other patients' characteristics such as chronic diseases, age, gender, marital status, social relationships, and level of education on HRQoL

among type 2 diabetes patients, many studies have been conducted.^{26–28} The result of this study confirmed that cigarette smoking and lower level of education had a significant negative influence on PCS score. The negative effect of cigarette smoking on HRQoL scores in type 2 diabetes patients has been confirmed.²⁹ A study conducted in Turkey proved the negative effect of low educational level on HRQoL scores.^{27,30} According to our knowledge, the effect of educational level on physical activity domains or PCS score has not been conducted. The researchers of the present study are of the opinion that patients with lower levels of education were engaged in jobs that require hard physical activity, and this can lead to worse general health compared to the patients with higher education level. The finding of the present study did not confirm

Table 2 Comparison between type 2 diabetes and healthy people

Domain	Healthy people	Type 2 diabetes	P-value
PF	64.03±27.93	57.99±28.17	0.039*
PR	60.47±22.39	58.62±23.02	0.434
RE	59.56±21.60	58.53±21.22	0.643
VT	44.54±15.68	42.44±21.60	0.225
MH	52.59±13.23	49.51±13.66	0.028*
SF	57.94±26.66	54.37±25.55	0.190
BP	47.55±28.14	49.75±27.41	0.446
GH	48.32±19.45	44.05±16.71	0.02*
PCS	67.47±22.09	61.91±22.94	0.018*
MCS	93.33±20.02	60.82±23.52	<0.001*

Notes: *P-value<0.05 is significant.

Abbreviations: PF, physical function; PR, physical role; RE, emotional role; SF, social function; BP, bodily pain; MH, mental health; VT, vitality; GH, general health; MCS, mental component summary; PCS, Physical component summary.

the significant effect of any metabolic variable on the MCS scale score. According to the researchers' knowledge,

there is no study that has investigated the effects of metabolic variables on MCS, in addition, studies that explore the effects of these variables on the psychological health of type 2 diabetes patients are rarely found. In the present study, MCS score was influenced positively by smoking, gender, and higher level of education.

As is the case for PCS scale, an increase in the level of education leads to higher MCS score. The present study is in line with another study that showed higher VT and EM domain scores in patients with international education.¹² Diabetic patients with higher education may have better quality of life due to the fact that they can study more about the symptoms and complications of their disease; thus, they are likely to pay more attention to treatment and diet.³¹ On the other hand, education is a necessary factor in comprehension of self-care management of diabetes and perception of self-esteem.³²

Table 3 The effects of metabolic variables on two main scales of SF-36 in type 2 diabetes

	β	95% C.I for β	P-value
PCS score			
Cigarette smoking	-15.761	(-16.06, -19.42)	0.009
Drug use	-12.636	(-14.26, -9.06)	0.542
Gender			
Men	-3.315	(-15.682, 9.21)	0.592
Women	Ref		
Education			
Diploma	-10.328	(-14.49, -6.32)	0.046
Bachelor	-5.041	(-7.92, 3.91)	0.597
MS	-3.541	(-7.01, 1.05)	0.359
Ph.D.	Ref		
Age	-0.011	(-0.25, 0.29)	0.950
BMI	-0.287	(-2.06, -0.17)	0.034
Blood Pressure			
Minimum	-0.039	(-0.04, -0.08)	0.009
Maximum	-0.108	(-0.068, -0.17)	0.008
Metabolic variables			
Chol	-0.648	(-0.73, -0.39)	0.006
TG	-0.116	(-0.16, 0.13)	0.096
HDL-C	0.867	(-0.99, 2.36)	0.058
LDL-C	-0.721	(-2.19, -0.69)	0.008
FBS	-0.769	(-1.33, -0.56)	0.006
HbA1c	-0.878	(-1.27, -0.41)	0.004
MCS score			
Cigarette smoking	13.032	(10.98, 15.19)	0.041
Drug use	26.78	(23.41, 29.19)	0.631

(Continued)

Table 3 (Continued).

	β	95% C.I for β	P-value
Gender			
Men	15.633	(12.81, 19.55)	0.018
Women	Ref		
Education			
Diploma	-13.161	(-17.58, -10.72)	0.027
Bachelor	-9.57	(-11.15, -8.04)	<0.001
MS	-1.69	(-6.19, -0.55)	0.045
Ph.D.	Ref		
Age	-0.076	(-0.36, 0.21)	0.598
BMI	-0.088	(-3.89; -0.025)	0.048
Blood Pressure			
Minimum	-0.017	(-0.08, 0.03)	0.419
Maximum	-0.09	(-0.20, 0.09)	0.221
Metabolic variables			
Chol	0.108	(-4.09, 1.11)	0.637
TG	-0.031	(-7.15, 2.09)	0.765
HDL-C	-0.291	(-2.59, 3.14)	0.399
LDL-C	-0.192	(-3.20, 4.26)	0.402
FBS	0.063	(-3.98, 1.91)	0.407
HbA1c	0.084	(-2.02, 1.85)	0.387

Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL-C cholesterol; Chol, High-density lipoprotein cholesterol; HbA1c, Hemoglobin A1c; BMI, Body Mass Index; FBS, Fasting blood sugar; TG, Triglycerides; MCS, mental component summary; PCS, Physical component summary; Ref, Reference category.

BMI had a negative influence on both PCS and MSC scores, and that is in line with Kalda et al,³³ who used logistic regression analysis, and showed that BMI had a negative effect on the quality of life of diabetic patients. A review by Kushner et al,³⁴ that focused on the relation between obesity and quality of life, found that obesity has negative effects on both physical and mental aspects of HRQoL. It is worth mentioning that Sepúlveda et al³⁴ indicated that overweight diabetic patients had lower score in PF and VT domains than the ones with normal weight.

In the present study, gender (men rather than women) had a significant positive effect on MCS scale, ie, Iranian diabetic women had lower MCS score compared to men. This result is not in accordance with the results of Dogan et al, that showed significant differences in PCS scores between women and men, however no significant difference in MCS scores.⁹ Age had no significant effect on the PCS and MCS scores in patients with diabetes in this study, but the consensus of the studies is that quality of life has a negative relationship with age.³²

It is obvious that patients with diabetes in this study had lower scores in PCS and MCS scale than healthy people.

This result is similar to other studies.³⁵ The comparison between patients and healthy people based on domain scores showed that MH, PF, and GH domains had significantly lower scores. The present study is the first one that has used multivariate regression in order to establish the effect of metabolic variables on PSC and MSC scores simultaneously.

Conclusion

The effect of HRQoL (as a concept of health) on patients with type 2 diabetes could be improved by controlling the variation of some metabolic variables. The results of this study can help physicians improve the HRQoL of patients with type 2 diabetes, based on some metabolic variables which are reported in their routine blood tests.

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Disclosure

The authors report no conflicts of interest in this work.

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