

Assessment of impact of comorbidities on quality of life scores among diabetics and non-diabetics: A hospital based case control study in Garhwal division of Uttarakhand, India

Nath B¹, Gupta S. D.², Kumari R.³

¹ All India Institute of Medical Sciences, Raebareli

² IIMR, Jaipur

³ All India Institute of Medical Sciences, Rishikesh

Abstract

Background :

Health related quality of life (HRQoL) is an important patient reported outcome in any chronic disease, including diabetes and is the ultimate goal of health interventions. The objective of the study was to compare the Quality of Life (QoL) scores between patients with diabetes and those without diabetes. It also intended to compare QoL scores between the two with respect to comorbidities of various system, assess the association of increasing number of comorbidities on QoL scores in both the groups and find the determinants of QoL scores among diabetics using regression analysis.

Methods:

The present study was a hospital-based comparative study conducted in Garhwal division of Uttarakhand, India. The QoL scores were obtained using WHOQOLBREF questionnaire. Comparisons were made between 195 diabetics and an equal number of age and sex matched nondiabetics.

Results:

The total mean QoL score was significantly lower among diabetics in comparison to nondiabetics. Patients with diabetics with comorbidity of cardiovascular system reported highest mean QoL scores while those with respiratory comorbidities reported lowest mean scores. The mean QoL scores decreased with increasing number of co-morbidities in both diabetics and nondiabetics, however the inter group differences were not found to be significant. Presence of three or more comorbidities ($\beta = -9.5$), income ($\beta = 5.3$), type of family ($\beta = -5.9$) and use of alcohol ($\beta = 2.4$) were significant determinants of QoL among patients of diabetes.

Conclusion:

The study illustrates the expanding horizons of the effect of diabetes on all the domains of life of an individual and therefore proposes and reinforces the role of interventions not just limited to control of blood sugar levels but also to enhance the quality of life of an individual with diabetes.

Keywords: Diabetes Mellitus, Quality of life, Comorbidity, Chronic disease, Cross-sectional study

Correspondence email: rkaiims2012@gmail.com

 <https://orcid.org/0000-0002-5242-2198>

Copyright: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. (CC BY 4.0)

Introduction

Diabetes is a chronic metabolic disease, which has the potential to cause complications in almost all parts of the body and can thereby increase the risk of premature death. ^[1] The current global prevalence of diabetes among adults is 8.8%, implying that every eleventh adult is suffering with this disease. ^[2] The number of people with diabetes is constantly on rise and this rise is unfortunately more pronounced in middle income and low-income countries. ^[3] The world recorded a fourfold increase in number of patients with diabetes from 108 million in 1980 to 424 million in 2017. In the year 2000, India (31.7 million) reported having highest number of patients with diabetes globally, followed by China (20.8 million) and United States (17.7 million). ^[3]

Once diagnosed, diabetes stays with a person throughout his/her life. Patients are constantly challenged by various demands, decisions, and interventions required to keep the disease under control. These challenges, along with the slow unnoticed impact of disease on various organ systems of the body frequently compromise the quality of life of an individual. Health related quality of life (HRQoL) is an important patient reported outcome in any chronic disease, and is now realized to be the ultimate goal of any health intervention. HRQoL represents the effect of an illness as perceived by the patient and incorporates the patient's perspective of his/her physical, mental and social well-being. ^[4] It has been reported that HRQoL has a significant effect on overall life satisfaction in people experiencing major decrements in health status, such as that among patients with diabetes. ^[5]

While few studies have been conducted to assess the HRQoL among patients with diabetes and compare it with that among patients without diabetes, they have been limited to a specific comorbidity or comorbidities of a specific system. Studies providing a holistic comparison of QoL scores with respect to system-wise comorbidities among patients with diabetes and patients without diabetes are limited. Moreover, any similar study from the state of Uttarakhand in India is unavailable due to relative lack of research initiatives in the geographically difficult to access state. Uttarakhand has a population of 11.5 million and an unpublished study has reported that the state has more than two lakh cases of diabetes, while another study conducted in one of the thirteen districts in Uttarakhand reported a prevalence of 11%, which is higher than global prevalence of 8.8%. ^[6,7]

The present study therefore attempts to assess and compare the QoL scores among patients with diabetes and patients without diabetes, with respect to type and number of comorbidities in a comprehensive manner. In addition to this, the study also attempts to find out the determinants of QoL scores among patients with diabetes.

Method

Study Design: A comparative study with two arms (patients with diabetes and without diabetes) was conducted in a tertiary care hospital of Garhwal division of Uttarakhand with two arms.

Study Setting: Uttarakhand state lies on southern slope of the Himalayan range and shares borders with China (Tibet) in the north and Nepal in the east. Garhwal is the western region and administrative division of Uttarakhand. Present study was conducted in the OPD of the medicine department of the Hemwati Nandan Bahuguna (HNB) Hospital. This hospital is a 750 bedded tertiary care hospital of Veer Chandra Singh Garhwali Government Medical Sciences and Research Institute. It mainly caters to the patients from middle and upper Himalayan region of state Uttarakhand, India. The period of data collection was from November 2017 to August 2018.

Study participants: Patients more than or equal to 30 years of age, under treatment for type 2 diabetes mellitus (T2DM) for at least 6 months were eligible for inclusion in the study. Pregnancy was considered to be an exclusion criterion for both diabetics and nondiabetics. An equal number of age and sex matched individuals who were nondiabetics, were recruited from amongst the attendants of patients consulting for acute diseases in the various OPDs of the hospital. Nondiabetics were individuals without a self-reported history of diabetes, who had never been diagnosed for diabetes by a physician. Their non-diabetic status was confirmed by a random blood sugar reading of less than 126 mg/dl by a glucometer. Both diabetics and nondiabetics were pair matched for age (within 2 years range) and sex. For some of the diabetics, especially very elderly ones, where matched nondiabetics could not be obtained from amongst the attendants in the hospital, were selected from the nearby community. Recruitment of both diabetics and nondiabetics was done consecutively from the hospital till the final sample size was achieved in both the groups.

Sample size: Sample size for the present study was calculated for comparing mean QoL scores between

patients with diabetes & those without diabetes. Taking a mean score of 60.68 ± 12.84 among diabetics [11] and assuming a 5-point difference between the two groups' means scores, with a SD of 10 in control group, alpha error of 0.05 and power of 80%, we obtained a sample size of 85 in each group.

The present study was a part of larger study with the primary objective of estimating the risk of comorbidities among diabetics in comparison to nondiabetics. [8] Taking the ratio of nondiabetics and diabetics (r) as 1, proportion of comorbidity (hypertension) in diabetics (p_1) and nondiabetics (p_2) as 47% [9] and 33.2% [10] respectively, average proportion exposed ($p = (p_1 + p_2) / 2$) = 0.4, effect size $((p_1 - p_2) / 2) = 0.14$, alpha error of 0.05% and power of 80%, the sample size (n) obtained for each group for the primary objective was 192. Taking the higher sample size, we recruited 195 participants in each group for meeting the sample size requirements of both the objectives.

Tool of data collection: A pre-tested pre-designed quantitative structured interview schedule was used to record information regarding sociodemographic characteristics, addiction status and comorbidities. For the purpose of current study, operational definition of comorbidity refers to presence of two or more than two diseases that occur in a person at the same time, which are presumably coincidental such as tuberculosis, hypertension, cardiovascular diseases, cancer etc. or occur as a result of complications of the diabetes such as retinopathy, neuropathy or nephropathy etc. [12, 13]

Information regarding status of comorbidities was obtained by enquiring about presence of any comorbid condition/s, which were cross verified by clinical examination and medical records if available. Complete clinical examination was also carried out among all the participants for any hidden/unreported comorbid condition/s. The clinical examination was done systematically by principal investigator, who is a post graduate in Community Medicine, to avoid any bias. Suitable laboratory investigation reports, if available, were used to substantiate the presence of comorbid conditions. Operational definitions were used for assessing comorbidities.

Information on tool used for measuring Quality of Life: QoL scores were assessed using WHOQOLBREF questionnaire (Hindi version) which is a 26 item validated instrument for measuring quality of life and covers four domains i.e. physical, psychological, social and environmental

domain. The measures from this instrument can be used in a particular cultural setting, and at the same time, the results are comparable across cultures. Besides comparing the QoL scores in four domains, there are two items that are examined separately and which measure an individual's overall perception on quality of life and health. Their scores are included in calculation of total scores. Scores are scaled in a positive direction i.e. higher scores denote higher quality of life. The scoring of each question and calculation of domain scores was done according to the method described in the WHOQOLBREF manual. [14]

Biases and measures taken to control them:

Selection Bias - Patients of diabetes were recruited consecutively from Medicine OPD of the health facility as the list of all patients with diabetes treated at the hospital was not available for random selection. The nondiabetics were selected consecutively from the hospital, except a few who were recruited from the community.

Recall Bias - To overcome recall bias in the study, same time duration along with same interview schedule was used among both diabetics and nondiabetics.

Non-response bias: The non-response bias was assessed on the basis of response among diabetics and nondiabetics. None of the diabetics recruited during the study declined to participate in the study, however three nondiabetics declined to participate in the study.

Information bias: Standard questionnaire was used for collecting information regarding QoL. Comorbidities were assessed based on operational definitions and standard procedures of clinical examination.

Interviewer Bias: Data was collected by the same investigator to overcome interviewer bias.

Statistical Analysis: Data was entered and analyzed using IBM SPSS statistics for windows, (version 23.0). Association between means were analysed using independent t test. Results of Levene's test for equality of variances, were used to determine the values of t test for equality of means reported in the results. If the Levene's test results were significant ($p < 0.05$), equal variances were not assumed and t test results were reported accordingly. One way ANOVA was used for comparison of means in more than three groups. Post-hoc Tukey's test was applied to find the differences between particular groups. A p value of less than 0.05 rejected the null

hypothesis of no association and favored the acceptance of alternate hypothesis. Multiple linear regression analysis was applied to study the effect of determinant variables after controlling for any potential confounders using SPSS and CRAN-R (2.4 version).

Results:

Mean age of diabetics was 56.8 years with a standard deviation (SD) of 12.4 years, while that for nondiabetics was 54.4 years \pm 12.3 years. The proportion of males in both the groups was slightly higher in comparison to females but the distribution was similar in both the groups (p value >0.05). Age and sex distribution of both the groups was similar as they were matched for these variables (p value >0.05). Both diabetics and nondiabetics were also found to be comparable with respect to marital status, religion, caste, educational status family size and alcohol use (p value >0.05). However, differences were observed between the two groups with respect to occupation, income, socioeconomic status and family history of diabetes (p value <0.05). Mean duration of diabetes was 6.4 years and proportion of diabetics using alcohol was 46.1%. (Not shown in table)

Table 1 shows that the mean scores of various domains of QoL were significantly lower in diabetics as compared to nondiabetics except for social domain. Overall mean score of QoL was also significantly lower among diabetics (102.4 ± 18.8) as compared to nondiabetics (111.9 ± 16.6).

Table 2 shows the percentage QoL scores which were calculated to determine the effect of disease on different domains and overall QoL scores. They were calculated by dividing the individual scores obtained by participants with the maximum score and multiplied by 100 to obtain a percentage. Further, mean, SD and mean difference of these percentage scores were calculated. The most severe impact of disease was observed on the physical domain in both the groups but more so among cases. This was followed by psychological domain among diabetics and social domain among nondiabetics. The overall scores among diabetics was 79% of maximum, while that among nondiabetics was 86% of maximum. The differences were observed to be significant.

Table 3 shows a comparison of mean scores of overall QoL in participants with comorbidities of different systems. The mean QoL scores were significantly lower among diabetics in comparison to nondiabetics with respect to comorbidities of all the systems except renal, nervous and psychiatric system. Diabetics with comorbidity of cardiovascular system reported highest mean score of QoL (92.5 ± 15.6) while those with respiratory comorbidities reported lowest mean score (84.1 ± 18.1), followed closely by psychiatric comorbidity; the corresponding figures among nondiabetics were highest for skin disorders (100.5 ± 11.4) and lowest for nervous system comorbidities (89.2 ± 16.4). It was interesting to note that among nondiabetics only those with nervous system or psychiatric comorbidities had scores lower than the highest score of 92.5 among patients of diabetes.

Table 1: Comparison of various domains of QoL scores among diabetics and nondiabetics

Domains (Maximum score)	Diabetics(195)	Nondiabetics (195)	Mean difference (95%CI)	't' statistic ^b	p-value
	(Mean \pm SD)	(Mean \pm SD)			
Physical(35)	23.4 \pm 5.2	25.9 \pm 4.0	2.5 (1.6-3.4)	5.0 ^a	0.00
Psychological(30)	23.9 \pm 5.1	26.1 \pm 4.5	2.2 (1.2-3.1)	4.5	0.00
Social relationships(15)	12.2 \pm 2.6	12.4 \pm 2.1	0.2 (-0.3- 0.7)	0.8 ^a	0.40
Environment(40)	32.9 \pm 6.0	35.0 \pm 5.7	2.1 (0.9-3.3)	3.5	0.00
Total Score(130)	102.4 \pm 18.8	111.9 \pm 16.6	9.5 (5.9- 13.0)	5.2 ^a	0.00

^a Levene's test for equality of variances was significant, ^b df 388

* $p < 0.05$ was considered significant

Table 2: Comparison of percentage scores of various domains of quality of life among diabetics and nondiabetics

Domains (Maximum score)	% score among diabetics (Mean ± SD)	% score among nondiabetics (Mean ± SD)	Mean difference (95%CI)	't' statistic	p-value
Physical(35)	66.8 ± 15.0	74.2 ± 11.5	7.4 (4.8-10.1)	5.5 ^a	0.00
Psychological(30)	79.8 ± 16.9	86.9 ± 15.1	7.2 (3.9-10.3)	4.4	0.00
Social relationships(15)	81.3 ± 17.5	82.9 ± 14.3	1.6 (-1.6-4.8)	0.99 ^a	0.32
Environment(40)	82.4 ± 15.0	87.6 ± 14.3	5.2 (2.3-8.1)	3.5	0.00
Total Score(130)	78.8 ± 14.5	86.1 ± 12.8	7.3 (4.6-10.0)	5.2 ^a	0.00

^a Levene's test for equality of variances was found to be significant,

* p<0.05 was considered significant.

Table 3: System wise comparison of QoL scores between diabetics and nondiabetics

System	Diabetics (Mean ± SD)	Nondiabetics (Mean ± SD)	Mean difference (95%CI)	't' statistic	p-value
CVS	92.5 ± 15.6	99.9 ± 11.8	7.4 (2.5- 12.2)	3.0 ^a	<0.00
Renal	87.0 ± 15.0	96.4 ± 14.3	9.4 (-5.7 -24.5)	1.3	0.20
Nervous system	87.1 ± 16.6	89.2 ± 16.4	2.1(-5.4- 9.6)	0.5	0.58
Ophthalmic system	90.7 ± 17.8	96.4 ± 14.5	5.7 (0.7- 10.8)	2.2 ^a	0.03
Respiratory	84.1 ± 18.1	100.2 ± 13.3	16.1 (3.2-28.9)	2.6	0.02
Musculoskeletal	90.0 ± 15.9	98.5 ± 14.5	8.5 (3.1- 13.9)	3.1	<0.00
Dermatologic	90.0 ± 16.2	100.5 ± 11.4	10.5 (3.9-17.1)	3.2 ^a	<0.00
Psychiatric	84.8 ± 17.4	90.4 ± 14.5	4.0 (-2.3-13.6)	1.4	0.16

^a Levene's test for equality of variances was significant,

* p<0.05 was considered significant

Table 4: Comparison of total quality of life scores among diabetics and nondiabetics with increasing number of comorbidities

Number of comorbidities	QoL scores		Mean difference (95%CI)	't' statistic	p-value
	Diabetics (Mean ± SD)	Nondiabetics (Mean ± SD)			
No comorbidity	100.76 ± 16.3	101.5 ± 14.9	0.74 (-6.0-7.4)	0.2	0.82
One comorbidity	96.5 ± 17.3	98.2 ± 15.9	1.7 ^a (-5.0-8.4)	0.7	0.45
Two comorbidity	93.8 ± 15.5	99.2 ± 10.9	5.4 (-0.6 – 11.4)	1.7	0.07
Three or more	85.8 ± 15.8	88.5 ± 16.3	2.7 (-7.9-13.3)	0.5	0.61

^a Levene's test for equality of variances was significant,

* p<0.05 was considered significant.

Table 4 shows that the mean scores of QoL decreased with the increasing number of comorbidities among cases, however this trend was not observed among nondiabetics. The total QoL score was lower among diabetics as compared to nondiabetics for different number of comorbidities but the differences were not found to be significant.

Table 5 shows that the diabetics with three or more comorbidities had lowest mean scores of QoL with respect to all the domains, in comparison to those with lesser number of comorbidities or no comorbidities. These differences were found to be statistically significant on applying ANOVA ($p < 0.05$) across all the domains as well as with respect to overall QoL scores. On applying tuckey's test in post hoc analysis it was observed that diabetics with three comorbidities had significant differences in comparison to those with no or one

comorbidity (except in psychological domain with one comorbidity) for all the domains of QoL.

Table 6 shows that except for QoL scores in physical domain, none of the other domains showed significant difference in QoL scores among nondiabetics with respect to different numbers of comorbidities.

Table 7 shows that on applying stepwise linear regression analysis, significant determinants of poor QoL among diabetics were, presence of three or more comorbidities, income, type of family and use of alcohol. The presence of three comorbidities ($\beta = -9.5$) and joint family ($\beta = -5.9$) was associated with lower QoL while high income ($\beta = 5.3$) and use of alcohol ($\beta = 2.4$) were positively associated with QoL. The coefficient of determination for the model was 24%.

Table 5: Comparison of domain wise quality of life scores among diabetics with different numbers of comorbidities

Domains of QoL	QoL scores among Diabetics with				'F' value	p value ^a
	No comorbidity (25) (Mean \pm SD)	One comorbidity (41) (Mean \pm SD)	Two co-morbidities (59) (Mean \pm SD)	≥ 3 co-morbidities (70) (Mean \pm SD)		
Physical	26.0 \pm 4.4	24.4 \pm 4.7	24.0 \pm 4.9	21.1 \pm 5.3	7.9	<0.00
Psychological	25.8 \pm 5.2	24.7 \pm 5.0	24.2 \pm 4.9	22.4 \pm 4.8	3.6	0.01
Social relationships	12.9 \pm 2.7	13.0 \pm 2.4	12.3 \pm 2.4	11.3 \pm 2.5	4.7	<0.00
Environment	35.9 \pm 5.3	34.3 \pm 6.5	33.1 \pm 5.7	30.8 \pm 5.4	6.0	<0.00
Total Score	100.7 \pm 16.3	96.5 \pm 17.3	93.8 \pm 15.5	85.8 \pm 15.8	7.0	<0.00

^a statistical significance was analysed by ANOVA with no. of comorbidities as a covariant

Table 6: Comparison of Quality of Life scores among nondiabetics with different numbers of comorbidities

Domains of QoL	QoL Scores among Nondiabetics with				'F' value ^a	p value
	No comorbidity (96) (Mean \pm SD)	One comorbidity (55) (Mean \pm SD)	Two comorbidities (34) (Mean \pm SD)	≥ 3 comorbidities (10) (Mean \pm SD)		
Physical	26.8 \pm 3.8	25.5 \pm 4.3	25.5 \pm 3.2	22.0 \pm 4.1	5.3	<0.00
Psychological	26.7 \pm 4.3	25.3 \pm 4.8	26.2 \pm 4.1	23.5 \pm 5.8	2.3	0.27
Social relationships	12.6 \pm 2.2	12.3 \pm 2.2	12.2 \pm 1.5	11.4 \pm 1.8	1.1	0.35
Environment	35.3 \pm 5.9	35.0 \pm 6.0	35.1 \pm 4.2	31.6 \pm 5.9	1.3	0.08
Total Score	101.5 \pm 14.9	98.2 \pm 15.9	99.2 \pm 10.9	88.5 \pm 16.3	2.6	0.05

^a Statistical significance was analysed by ANOVA with number of comorbidities as a covariant

Table 7: CLinear regression analysis for determinants of QoL score among diabetics

Determinant variables in the model	β^a	SE	T value	p-value
Constant	83.9	5.3	15.6	0.00
Comorbidities (0=no comorbidity, 1= three or more comorbidities)	-9.5	2.2	-4.2	0.00
Income (0= <10000/month, 1= \geq 10000/month)	5.3	1.0	5.0	0.00
Type of Family (0=nuclear family, 1=joint family)	-5.9	2.1	-2.8	0.01
Alcohol use (0=no use, 1=currently using)	2.4	1.1	2.0	0.04

^a Unstandardized Coefficient

Discussion

The present research was conducted with an objective of comparing QoL scores among diabetics and non-diabetics and also tried to determine the effect of different comorbidities on QoL scores in both the groups. Age and sex matching, incidentally lead to comparable baseline characteristics of both the groups, for most of the variables except occupation, income and SES, which is quite understandable, given the fact that diabetes affects people with sedentary habits and those with high income.

The tool used for assessment of quality of life of study participants in the present study was WHO-QOLBREF questionnaire, which is a standardized questionnaire and has been validated internationally as well as nationally. Another advantage of using this questionnaire was that it includes questions to assess the physical, environmental, social and psychological domains, which provide a complete picture of the quality of life of an individual. Other questionnaires, such as SF12, SF-36, and HRQoL assess only the physical and mental domains. ^[14]

Diabetes is a disease affecting overall QoL as well as all the domains of quality of life of an individual, a finding that was evident by significantly lower total and domain wise QoL scores among diabetics as compared to the nondiabetics in the current study. It has demonstrated that diabetes has a significant impact on QoL when coupled with comorbidities of almost all body systems. The impact of these comorbidities on scores were observed to be more

pronounced among diabetics as compared to the nondiabetics, emphasizing the role of prevention of comorbidities in diabetes. Studies from different parts of the world have reported similar findings, while using different questionnaires^[16-24]. A case control study from nearby country of Bangladesh, used EuroQol (EQ) visual analogue scale (VAS) for measuring QoL and reported that mean EQ-VAS score of patients with diabetes was 11.5 points lower (95 %-CI: -13.5, -9.6) compared to without diabetes. ^[24] We observed a difference of 9.5 (95% CI: 5.9- 13.0) points in the mean QoL scores between the two groups. Another hospital based study done in the capital city of the same state where the present study was carried out, also reported a high prevalence of “extremely bad quality of life” among 56% and “very bad quality of life” among 40% of patients with diabetes. ^[23]

Domain-wise QoL score analysis showed similar mean QoL scores in various domains when compared with another study from Iran. The most severe impact of the disease was observed on the physical domain with the mean score being just 66.8% of the maximum as compared to 74% among controls. The other domains reported a 20% decline in QoL scores among diabetics as compared to 12-17% among controls. It was disturbing to note that social domain was equally affected in both the groups and is a reflection of decreased social interactions among people in general.

Our study showed significant differences in various domains of QoL scores between two groups except the domain of social relationship, which was in contrast to a case control study from Maharashtra,

where none of the domains showed significant differences in the two groups.^[17] This implies that the disease in this region of India affects almost all the domains of life of an individual and therefore warrants intervention at an earlier stage for mitigating the effect of disease on quality of life of an individual.

Assessment of impact of comorbidities of various body systems on QoL among patients with diabetes showed that respiratory comorbidities had maximum impact (mean QoL score 84.1 ± 18.1) whereas CVS comorbidities had lowest impact on QoL with highest mean score of QoL (92.5 ± 15.6). While these findings were similar to the findings of Adriaanse et al and Wee et al, they differed from other studies which reported the lowest QoL scores among patients with comorbidity of renal system.^[25,26] It would be worth noting that impact of comorbidities of renal, nervous and psychiatric system had similar but severe impact on QoL in both diabetics and nondiabetics with no significant difference between the two groups, emphasising the impact of these diseases on QoL of every individual.

The strong dose response relationship between the number of comorbidities and total as well as domain wise QoL scores observed among diabetics in this study is similar to the findings of other researchers.^[16,20,27-28] Marcel C. Adriaanse et al have also reported a strong dose-response relationship between comorbidities and physical QoL, where they reported a significant negative correlation between comorbidities and QoL scores.^[16] Shamsirgaran et al in a study from Iran also found that with increase in number of comorbidities, there was decrease in QoL scores with respect to various domains, however, in contrast to the present study they did not find significant differences in the domains except for social domain.^[25]

Determinants of QoL score among patients of diabetes

Sex and duration of diabetes have been reported to be important determinants of QoL among diabetics in researches from other parts of world.^[24,25,26] Duration of diabetes was reported to be significant in our study in univariate analysis however, it lost its significance when it was adjusted with other factors. Other studies from different parts of the world have reported different determinants of QoL among patients with diabetes and include sex, marital status, monthly household income (MHI), comorbid renal disease, lower education, unemployment, long duration of diabetes, diabetes - related

hospitalization in past years, having nephropathy, lower extremity lesion, presence of retinopathy, increase in age, HbA1c, obesity and hypertension.^[18,29] We did not include factors such as hospitalization, retinopathy, obesity, hypertension, HbA1C in the regression model, Significant determinants in the present study included presence of three comorbidities, type of family, high income and use of alcohol.

Conclusions and recommendations

The present study shows that comorbidities significantly impact the QoL of persons with diabetes and all the domains are affected by the disease. The study highlights the expanding horizons of the impact of diabetes on all the aspects of the life of an individual including physical, psychological, environmental, as well as social aspects. There is need to control the onset of disease by primordial prevention at the first stage and further by primary and secondary prevention measures to halt the onset of comorbidities, which are deemed to adversely affect the QoL and other aspects of life of a diabetic person.

Limitations of the study

The proposed study was conducted among patients attending the tertiary level hospital and therefore may have a limited external validity for general population. Being a hospital based study, the differences in comorbidities between diabetics with more than 6 months' duration and non-diabetics in general population would be larger than what was obtained in the present study and the results obtained are an underestimation of the actual problem, thereby implying that the magnitude of the problem is larger than what has been reported. However, in view of the limited resources available, it was not possible to conduct a community-based cross-sectional study and the results still hold great relevance by being unique in providing comparisons between diabetics and non-diabetics with respect to the type and number of comorbidities.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. World Health Organization. Global report on diabetes. <https://www.who.int/diabetes/-global-report/en/>. Accessed October 25, 2019.
2. Ogurtsova K, da Rocha Fernandes JD, Huang Y, et al. IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Research and Clinical Practice*. 2017 ;128:40-50.
3. Kaveeshwar SA, Cornwall J. The current state of diabetes mellitus in India. *The Australasian Medical Journal*. 2014;7(1):45.
4. Megari K. Quality of life in chronic disease patients. *Health Psychology Research*. 2013;1(3).
5. Rubin RR, Peyrot M. Quality of life and diabetes. *Diabetes/metabolism research and reviews*. 1999;15(3):205-18.
6. Uttarakhand has more than two lakh type II diabetes-affected patients. <https://timesofindia.indiatimes.com/city/dehradun/Uttar-khand-has-more-than-two-lakh-type-II-diabetes-affected-patients/article-show/49772702.cms>. Accessed April 12, 2019.
7. Hasan I, Khatoon S. Prevalence of diabetes mellitus and obesity among population of Sultanpur kunhari and its surrounding area, Haridwar Uttarakhand. *International Research Journal of Pharmacy*. 2012;3(2):226-8.
8. Charan J, Biswas T. How to calculate sample size for different study designs in medical research?. *Indian Journal of Psychological Medicine*. 2013;35(2):121.
9. Patel M, Patel IM, Patel YM, Rathi SK. A hospital-based observational study of type 2 diabetic subjects from Gujarat, India. *Journal of Health, Population, and Nutrition*. 2011; 29(3):265
10. Pooja P, Mittal Y. Prevalence of hypertension among rural population of Doiwala block, Dehradun, Uttarakhand India. *Recent Research in Science and Technology*. 2013;5(1).
11. Raghavendra N, Viveki RG, Gadgade A. An observational study to assess the health-related quality of life of type 2 diabetes mellitus patients attending a tertiary care hospital, Belagavi. *International Journal of Community Medicine and Public Health*. 2017;4(9):3 347-53.
12. Kendir C, van den Akker M, Vos R, Metsemakers J. Cardiovascular disease patients have increased risk for comorbidity: A cross-sectional study in the Netherlands. *European Journal of General Practice*. 2018; 24(1):45-50.
13. Wang J, Ma JJ, Liu J, Zeng DD, Song C, Cao Z. Prevalence and risk factors of comorbidities among hypertensive patients in China. *International Journal of Medical Sciences*. 2017;14 (3):201.
14. Saxena S, Chandiramani K, Bhargava R. WHOQOL-Hindi: A questionnaire for assessing quality of life in health care settings in India. *National Medical Journal of India*. 1998;11:160-5.
15. Nath B, Gupta SD, Kumari R. Effect of comorbidities on direct cost among type 2 diabetes mellitus (T2DM) patients in tertiary care government hospital in Uttarakhand, India: A primary data analysis of out of pocket expenditure. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2020 Nov 1;14(6):2153-9
16. Adriaanse MC, Drewes HW, van der Heide I, Struijs JN, Baan CA. The impact of comorbid chronic conditions on quality of life in type 2 diabetes patients. *Quality of Life Research*. 2016;25(1):175-82.
17. Jain V, Shivkumar S, Gupta O. Health-related quality of life (hr-qol) in patients with type 2 diabetes mellitus. *North American Journal of Medical Sciences*. 2014;6(2):96.
18. Demirci H, Cinar Y, Bayram N, Bilgel N. Quality of life in type II diabetic patients in primary health care. *Dan Med J*. 2012;59(10) :A4468.
19. DR Barometer Global Report.https://drbarometer.com/wp-content/uploads/2016/11/DRBarometer_Global_Report.pdf.
20. Aghakoochak A, Shojaoddiny-Ardekani A,

- Vakili M, Namiranian N. Quality of life in diabetic patients: A case-control study. *Iranian Journal of Diabetes and Obesity*. 2014;**6**(1):28-33
21. Mohammadi S, Karim NA, Talib RA, Amani R. Evaluation of quality of life among type 2 diabetes patients. *International Journal of Community Medicine and Public Health*. 2017;**3**(1):51-6.
 22. Kiadaliri AA, Najafi B, Mirmalek-Sani M. Quality of life in people with diabetes: a systematic review of studies in Iran. *Journal of Diabetes & Metabolic Disorders*. 2013;**12**(1):54
 23. Shekhar AS, Venkateshan M, ManoRanjini J, Jugdeo S, Baluni R. Study the Effectiveness of Mindful Eating on Quality of Life among Adults with Type 2 Diabetes Mellitus in Selected Hospital of Dehradun, Uttarakhand. *International Journal of Nursing Education*. 2017;**9**(2):87-93.
 24. Safita N, Islam SM, Chow CK, et al. The impact of type 2 diabetes on health related quality of life in Bangladesh: results from a matched study comparing treated cases with non-diabetic controls. *Health and quality of life outcomes*. 2016;**14**(1):129.
 25. Shamshirgaran SM, Ataei J, Alamdari MI, Safaeian A, Aminisani N. Predictors of health-related quality of life among people with type II diabetes Mellitus in Ardabil, Northwest of Iran, 2014. *Primary Care Diabetes*. 2016;**10**(4):244-50.
 26. Javanbakht M, Abolhasani F, Mashayekhi A, Baradaran HR. Health related quality of life in patients with type 2 diabetes mellitus in Iran: a national survey. *PloS one*. 2012;**7**(8):e44526.
 27. Trikkalinou A, Papazafropoulou AK, Melidonis A. Type 2 diabetes and quality of life. *World Journal of Diabetes*. 2017;**8**(4):120
 28. Thommasen HV, Zhang W. Health-related quality of life and type 2 diabetes: A study of people living in the Bella Coola Valley. *British Columbia Medical Journal*. 2006;**48**(6):272.
 29. Papadopoulos AA, Kontodimopoulos N, Frydas A, Ikonomakis E, Niakas D. Predictors of health-related quality of life in type II diabetic patients in Greece. *BMC Public Health*. 2007;**7**(1):186.