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# Factors affecting health-related quality of life (HRQoL) in Pakistani children with thalassemia

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**A** – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

**Summary** **Background.** Thalassemic patients have deteriorated quality of life, which affects their social status, leisure activities, ability to focus on task or series of task and relationships.
**Objectives.** The objective of this study is to find factors associated with health-related quality of life (HRQoL) that either hinder or augment the effectiveness of therapy in thalassemia patients in Pakistan.
**Material and methods.** A cross-sectional observational study was conducted among 178 children and adolescents with thalassemia in Lahore, Pakistan. The clinical characteristics of patients were recorded by checking medical records, and HRQoL was calculated using the PedsQL (Pediatric Quality of Life Inventory) scale.
**Results.** The average of the total summary score of the study population was 63.91 (SD: 15.52). For the subscales of the PedsQL score, it was revealed that the social functioning score was 10.24 (SD: 5.55), school functioning score was 10.66 (SD: 4.75), emotional functioning score was 10.68 (SD: 3.78), physical functioning score was 14.84 (SD: 15.52) and general health functioning score was 17.49 (SD: 3.15). It was shown that age, rural residence, as well as serum ferritin, urea and AST levels, were significantly associated with HRQoL. White blood cell count, red blood cell count, platelet count and alanine transaminase were not significant predictors of HRQoL.
**Conclusions.** Keeping in mind the current scenario in Pakistan, our study revealed that there is a need for improvement in thalassemia treatment management. For this, a modification of healthcare services can improve HRQoL, and thus improve the percentage of treatment outcomes in thalassemic patients.
**Key words:** Quality of Life (HRQoL), thalassemia, Pakistan.

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## Background

Thalassemia is an inherited disease, which is now considered a serious health problem in the Middle East, Mediterranean region and South Asia [1]. Thalassemia is haemoglobinopathies characterised by decreased production of globin chains and, consequently, microcytic anaemia [2, 3]. According to a cross-sectional study in Thailand, more than 1.5% of the total global population has this anomaly [4]. Globally, there are around 300 million carriers of haemoglobinopathies [5]. Medically, patients with thalassemia face severe complications, such as heart failure, cardiac arrhythmias, liver diseases, endocrine complications and infections. Osteopenia and osteoporosis incidence is also seen in some patients [5–8]. Moreover, hypoadrenalism, a rare condition, is caused by elevated serum ferritin in older thalassemic patients [5, 8–12]. Significant fibrosis was seen frequently in some patients. Hyper-transfusion, inadequate chelation, erythrocyte catabolism and iron hyperabsorption cause iron overload, which may induce the progression of fibrosis [13].

The consequences of thalassemia are extremely stressful and can lead to various physical, psychological, social and financial problems. Thalassemic patients have deteriorated quality of life, which affects their social status, leisure activities, ability to focus on task or series of task and relationships [2, 5, 14]. Health-related quality of life in thalassemic patients is significantly low compared to healthy individuals [15]. Frequent transfusions, prolonged treatments and other comorbidities have a negative effect on health-related quality of life [16, 17]. Though frequent transfusions contribute to low health-related quality of life, existing evidence shows that transfusion independent patients also show low health-related quality of life scores [18]. Side effects of iron chelation [19, 20] and age [17] can be significantly associated with health-related quality of life in children with thalassemia, and factors like gender, ethnicity and household income are not significantly associated with PedsQL [20]. According to a published study, cultural differences did not affect health-related quality of life [21]. Moreover, patients with thalassemia showed overall symptoms of depression and anxiety [16]. Another study identified that the quality of life in school-age thalassemic patients is affected most [17]. In a study conducted in Pakistan, the importance in providing complete knowledge to parents about the disease and recovery of their children was highlighted [22]. This study aimed at finding the factors that relate to heath-related quality of life in the thalassemic children of Lahore, Pakistan.

## Objectives

The objective of study was to evaluate the factors affecting the HRQoL of thalassemic patients in Pakistan.

## Material and methods

### Participants and settings

A cross-sectional observational study was conducted among children and adolescents with thalassemia. The study design was approved, and ethics approval was granted by the review board on human research of the University College of Pharmacy (HEC-PUCP-08-2016). Participants in the study were selected based on the inclusion and exclusion criteria. Sample size was calculated using the Cochran Formula for prevalence [23].

### Inclusion criteria

Male or female patients, aged 5 years and above, diagnosed with *β*-thalassemia major with current serum ferritin higher than 1,000 ng/ml were included. Patients with a lifetime history of at least 20 units of red blood cell transfusions and who received at least ≥ 10 units/year of red blood cell transfusions were also included.

### Exclusion criteria

Patients participating in any clinical trial or receiving an investigational drug were not included. Non-compliant patients with more than 3 times chelator discontinuations longer than 2 months during the past 2 years were also excluded. Patients unwilling to participate in study were also not included. Patients who were suffering from co-morbid clinical conditions which may limit their ability to participate in study were also excluded.

### Instrument of measure

In this study, quality of life assessment was performed by using the pre-validated PedsQL questionnaire (Pediatric Quality of Life Inventory). The PedsQL questionnaire was selected, as it can evaluate the physical, psychological and social components of quality of life. It consists of two parts; one is a parallel child self-report, and the other is a parent proxy-report of the child's HRQoL. The PedsQL documents the perception of the patient about the impact of disease on various health and well-being domains [24, 25]. Its multidimensional generic core scales encompass the essential domains for paediatrician HRQoL assessment, including: physical functioning (8 items), emotional functioning (5 items), social functioning (5 items), school functioning (5 items), general well-being (6 items) and a global perception of overall health status (1 item). Scales are scored from 0 to 100, with 100 indicating a higher PedsQL. The generic scales are made to be used for assessing PedsQL in various public health conditions, like cancer, asthma and arthritis [26, 27]. We also recorded the basic demographics and clinical records of patients, which contained questions about gender, age, income source, diagnosis, Hb level, complications, serum ferritin level, iron chelation treatment, etc. Patient data was analysed by classifying patients into different groups.

### Data collection

All patients, along with their parents, were approached when they came to the thalassemia institution for routine follow-up. Written parental consent was taken before recruitment in the study. At the start of the interview, all the participants were informed about the nature of the study, why we were doing it and the use of our findings, and they were assured that the data would remain confidential. For the PedsQL, the questionnaire was filled in by interviewers addressing the responsive child or their parents. The questionnaire was completed independently by children of a minimum age of 8 years, and children greater than 8 years of age were interviewed. Informed consent was obtained from all participants.

### Data analysis

All the data collected was analysed using the SPSS (Statistical Package for the Social Sciences) program. Various characteristics of the patients were mentioned in terms of mean and standard deviation. In case of the PedsQL, summary scores and total HRQoL scores were mentioned in terms of mean and standard deviation. The Chi-square, ANOVA and *t*-Test were used to observe the relationship between each demographic/clinical factor and HRQoL.

## Results

The demographics characteristics of all patients are presented in Table 1.

**Table 1. General demographics**

| Parameters | Total |
|---|---|
| Gender | |
| male | 115 (64.6%) |
| female | 63 (35.4%) |
| Locality | |
| rural | 114 (64.0%) |
| urban | 64 (36.0%) |
| Income source | |
| self | 3 (1.7%) |
| dependent | 174 (98.3%) |
| Annual income | |
| < 20K | 171 (96.6%) |
| > 20K | 6 (3.4%) |
| Family history | |
| yes | 101 (56.7%) |
| no | 77 (43.3%) |
| Serum ferritin (ng/ml) | |
| yes | 101 (56.7%) |
| no | 77 (43.3%) |

**Table 2. Quality of Life Scores**

| Scale | Mean ± SD |
|---|---|
| Total summary score | 63.91 ± 15.52 |
| Physical health | 14.84 ± 5.31 |
| Emotional functioning | 10.68 ± 3.78 |
| Social functioning | 10.24 ± 5.55 |
| School functioning | 10.66 ± 4.75 |
| General health | 17.49 ± 3.15 |

In the study, 115 (64.6%) patients were male, and 63 (35.4%) patients were female. Out of a total of 178 patients, 114 (64.0%) were residents of rural areas, and the remaining 64 (35.4%) belonged to urban localities. Most of the participants (174 – 98.3%) were dependent on guardians, and only 3 (1.7%) were self-employed. A majority of the participants (171 – 96.6%) were lower middle class, with a monthly income greater than 20,000 PKR, and the remainder (3.4%) were classified as having a very low socio-economic status, with a monthly income below 20,000 PKR. It was observed that 101 (56.7%) of the participants had a family history of thalassemia, while the remaining 77 (43.3%) had no incidence of thalassemia in their family.

The HRQoL scores based on child self-reports are presented in Table 2. The mean (SD) total summary score of the study

population was 63.91 (15.52). For the subscales of the PedsQL, the score of the study revealed that social functioning scored the lowest (mean = 10.24; SD = 5.55), followed by the school functioning score (mean = 10.66; SD = 4.75), emotional functioning score (mean = 10.68; SD = 3.78), physical functioning score (mean = 14.84; SD = 15.52) and general health functioning score (mean = 17.49; SD = 3.15).

Table 3 and Table 4 show the HRQoL scores classified based on demographic and clinical characteristics, respectively. It was found that treatment protocols were not significantly related to the total summary score. This shows that the route of therapy, whether oral or subcutaneous (S/C), did not significantly influence the overall HRQoL score. Analysis of the subscales showed that patients who are on oral therapy showed better general health subscale scores (mean = 18.03; SD = 3.31) compared to oral therapy. Gender was not significantly related to the total summary score.

Patients living in rural areas (mean = 58.81; SD = 14.71) had significantly low total PedsQL scores compared to residents of urban areas (mean = 73.00; SD = 12.58). Patients residing in urban areas had significantly good physical functioning scores (mean = 17.25; SD = 4.35), emotional functioning scores (mean = 12.46; SD = 3.33), social functioning scores (mean = 13.26; SD = 4.62), school functioning scores (mean = 13.62; SD = 4.08) and general health scores (mean = 16.39; SD = 03.11) compared to the physical functioning scores (mean = 13.48; SD = 5.33), emotional functioning scores (mean = 9.68; SD = 3.65), social functioning scores (mean = 8.54; SD = 5.31), school functioning scores (mean = 9.00; SD = 4.28) and general health scores (mean = 18.10; SD = 03.01) of patients from rural areas.

The findings indicated that patients less than 12 years of age had significantly improved total PedsQL scores (mean = 68.22; SD = 14.10) compared to patients more than 12 years of age (mean = 60.70; SD = 15.8). Not only did they have better overall PedsQL, but they also showed significantly improved measures in the physical, emotional and social scales, as depicted in Table 3.

It was discovered that serum ferritin, urea and AST levels were significantly associated with HRQoL.

White Blood Cell Count (WBCs), Red Blood Cell Count (RBCs), Platelet Count and Alanine Transaminase were not significant predictors of the HRQoL score (Table 4).

**Table 3. Quality of Life Scores by Demographic Characteristics**

| | | Total | Physical | Emotional | Social | School | General |
|---|---|---|---|---|---|---|---|
| | | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| **Total Summary Scores of the Study Population** | | | | | | | |
| | *n* = 178 | 63.91 ± 15.52 | 14.84 ± 5.31 | 10.68 ± 3.78 | 10.24 ± 5.55 | 10.66 ± 4.75 | 17.49 ± 3.15 |
| **Treatment Protocol (Deferasirox vs Deferoxamine)** | | | | | | | |
| S/C | *n* = 90 | 63.01 ± 15.49 | 14.49 ± 5.69 | 10.41 ± 3.56 | 10.30 ± 5.55 | 10.85 ± 4.84 | 16.95 ± 2.90 |
| Oral | *n* = 88 | 64.84 ± 15.60 | 15.19 ± 4.89 | 10.96 ± 3.98 | 10.18 ± 5.57 | 10.46 ± 4.68 | 18.03 ± 3.31 |
| | *p* | 0.433 | 0.378 | 0.329 | 0.888 | 0.586 | 0.022* |
| **Gender** | | | | | | | |
| Male | *n* = 115 | 63.96 ± 16.28 | 14.50 ± 5.41 | 10.67 ± 3.85 | 10.22 ± 5.77 | 11.07 ± 4.89 | 17.49 ± 3.11 |
| Female | *n* = 63 | 63.84 ± 14.16 | 15.44 ± 5.10 | 10.71 ± 3.67 | 10.28 ± 5.17 | 9.90 ± 4.43 | 17.49 ± 3.24 |
| | *p* | 0.962 | 0.260 | 0.940 | 0.938 | 0.116 | 0.992 |
| **Residence** | | | | | | | |
| Rural | *n* = 114 | 58.81 ± 14.71 | 13.48 ± 5.33 | 9.68 ± 3.65 | 8.54 ± 5.31 | 9.00 ± 4.28 | 18.10 ± 3.01 |
| Urban | *n* = 64 | 73.00 ± 12.58 | 17.25 ± 4.35 | 12.46 ± 3.33 | 13.26 ± 4.62 | 13.62 ± 4.08 | 16.39 ± 3.11 |
| | *p* | 0.000** | 0.000** | 0.000** | 0.000** | 0.000** | 0.001** |
| **Family History of Disease** | | | | | | | |
| Yes | *n* = 101 | 64.88 ± 15.16 | 15.32 ± 5.24 | 10.83 ± 3.66 | 10.60 ± 5.70 | 10.95 ± 4.76 | 17.18 ± 3.07 |
| No | *n* = 77 | 62.65 ± 16.00 | 14.2 ± 5.36 | 10.49 ± 3.93 | 9.7 ± 5.34 | 10.28 ± 4.75 | 17.90 ± 3.22 |
| | *p* | 0.343 | 0.168 | 0.555 | 0.320 | 0.357 | 0.132 |
| **Age (Years)** | | | | | | | |
| ≤ 12 | *n* = 76 | 68.22 ± 14.10 | 16.14 ± 5.02 | 11.64 ± 3.38 | 12.01 ± 4.68 | 11.47 ± 4.84 | 16.95 ± 3.38 |
| >12 | *n* = 102 | 60.70 ± 15.82 | 13.86 ± 5.34 | 9.97 ± 3.91 | 8.92 ± 5.80 | 10.06 ± 4.62 | 17.89 ± 2.91 |
| | *p* | 0.001** | 0.004** | 0.003** | 0.000** | 0.490 | 0.470 |

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

**Table 4. Quality of Life Scores by Clinical Characteristics of the Patients**

| | | Total | Physical | Emotional | Social | School | General |
|---|---|---|---|---|---|---|---|
| | | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| **Serum Ferritin (ng/ml)** | | | | | | | |
| < 5000 | *n* = 84 | 60.32 ± 16.27 | 13.69 ± 5.75 | 9.99 ± 3.69 | 9.13 ± 5.97 | 9.67 ± 4.80 | 17.84 ± 3.26 |
| > 5000 | *n* = 94 | 67.13 ± 14.15 | 15.86 ± 4.67 | 11.31 ± 3.76 | 11.23 ± 4.96 | 11.55 ± 4.55 | 17.17 ± 3.02 |
| | *p* | 0.004** | 0.006** | 0.019* | 0.011* | 0.008* | 0.154 |
| **White Blood Cells ($10^3$ cells/mcL)** | | | | | | | |
| < 10 | *n* = 120 | 65.03 ± 15.12 | 15.43 ± 5.29 | 10.69 ± 3.57 | 10.82 ± 5.29 | 10.76 ± 4.77 | 17.33 ± 3.35 |
| > 10 | *n* = 58 | 61.60 ± 16.22 | 13.60 ± 5.18 | 10.67 ± 4.21 | 9.05 ± 5.91 | 10.465 ± 4.76 | 17.81 ± 2.67 |
| | *p* | 0.168 | 0.031* | 0.975 | 0.046* | 0.701 | 0.345 |

| Table 4. Quality of Life Scores by Clinical Characteristics of the Patients | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Total | Physical | Emotional | Social | School | General |
| | | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| **Red Blood Cells ($10^6$ cells/mcL)** | | | | | | | |
| ≤ 3 | *n* = 112 | 63.54 ± 15.88 | 14.65 ± 5.35 | 10.75 ± 3.93 | 9.99 ± 5.60 | 10.50 ± 4.58 | 17.65 ± 3.26 |
| > 3 | *n* = 66 | 64.54 ± 15.01 | 15.15 ± 5.25 | 10.57 ± 3.52 | 10.67 ± 5.47 | 10.94 ± 5.05 | 17.21 ± 2.95 |
| | *p* | 0.679 | 0.546 | 0.767 | 0.434 | 0.553 | 0.370 |
| **Platelets ($10^3$ cells/mcL)** | | | | | | | |
| < 200 | *n* = 73 | 63.07 ± 15.32 | 15.08 ± 5.03 | 10.52 ± 3.76 | 9.63 ± 5.44 | 10.22 ± 4.38 | 17.61 ± 3.31 |
| > 200 | *n* = 105 | 64.50 ± 15.71 | 14.67 ± 5.51 | 10.80 ± 3.79 | 10.67 ± 5.61 | 10.97 ± 4.99 | 17.40 ± 3.046 |
| | *p* | 0.545 | 0.609 | 0.629 | 0.221 | 0.301 | 0.653 |
| **Alanine Transaminase (IU/L)** | | | | | | | |
| < 56 | *n* = 98 | 62.36 ± 15.96 | 14.69 ± 5.59 | 10.06 ± 3.45 | 10.04 ± 5.703 | 10.15 ± 5.00 | 17.41 ± 3.11 |
| > 56 | *n* = 80 | 65.82 ± 14.85 | 15.01 ± 4.97 | 11.45 ± 4.03 | 10.49 ± 5.38 | 11.28 ± 4.39 | 17.59 ± 3.21 |
| | *p* | 0.139 | 0.692 | 0.014* | 0.595 | 0.114 | 0.707 |
| **Aspartate Transaminase (IU/L)** | | | | | | | |
| < 56 | *n* = 100 | 61.69 ± 15.86 | 14.39 ± 5.72 | 10.01 ± 3.54 | 10.00 ± 5.56 | 9.89 ± 4.96 | 17.40 ± 3.23 |
| > 56 | *n* = 78 | 66.77 ± 14.69 | 15.41 ± 4.69 | 11.55 ± 3.91 | 10.55 ± 5.55 | 11.65 ± 4.31 | 17.60 ± 3.05 |
| | *p* | 0.030* | 0.204 | 0.007* | 0.512 | 0.014* | 0.671 |
| **Urea (mg/dl)** | | | | | | | |
| ≤ 20 | *n* = 101 | 62.85 ± 16.12 | 13.90 ± 5.33 | 10.17 ± 3.93 | 10.11 ± 5.41 | 10.55 ± 4.66 | 18.12 ± 3.12 |
| > 20 | *n* = 77 | 65.31 ± 14.70 | 16.06 ± 5.06 | 11.36 ± 3.48 | 10.41 ± 5.76 | 10.80 ± 4.90 | 16.66 ± 3.00 |
| | *p* | 0.296 | 0.007* | 0.036* | 0.716 | 0.728 | 0.002** |

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

When looking at each summary score, patients with a WBCs count less than $10*10^3$ cells/mL had improved Physical Health and social functioning scores as compared to patients with more than $10*10^3$ cells/mcL WBCs count. Though ALT levels were not significantly associated with HRQoL, analysis of the subscales showed that ALT levels greater than 56 IU/ml showed significantly improved emotional functioning scores (mean = 11.45; SD = 4.03) compared to the emotional functioning scores (mean = 10.06; SD = 3.45) of patients with ALT less than 56 IU/ml.

In addition, urea levels were significant predictors of HRQoL. The findings showed that a urea count greater than 20 mg/ml was significantly related to the improved physical health summary score (mean = 16.66; SD = 5.06) and the emotional functioning scores (mean = 1.36; SD = 3.48) compared to the physical health summary score (mean = 13.90; SD = 5.33) and emotional functioning scores (mean = 10.17; SD = 3.93) of patients with urea levels less than 20 mg/ml.

The relationship between AST and PedsQL was significant. For the emotional and school functioning subscales, AST levels were significant predictors of HRQoL. Patients with AST levels greater than 56 IU/ml had improved total overall PedsQL scores (mean = 66.72; SD = 14.69) compared to patients with lower ALT levels (mean = 61.69; SD = 15.86). Patients with AST levels greater than 56 had improved emotional (mean = 11.55; SD = 3.91) and school functioning score (mean = 11.65; SD = 4.31) compared to the emotional (mean = 10.01; SD = 3.54) and school functioning scores (mean = 9.89; SD = 4.96) of patients who has AST levels lower than 56 IU/ml.

Serum ferritin is significantly associated with HRQoL, as depicted in Table 4. Patients with serum ferritin greater than 5,000 ng/ml showed significantly higher total summary scores (mean = 67.13; SD = 14.15) as compared to participants having less than 5000 ng/ml serum ferritin (mean = 0.32; SD = 16.27). Patients with serum ferritin less than 5,000 ng/ml had significantly lower physical functioning scores (mean = 13.69; SD = 5.75), emotional functioning scores (mean = 9.99; SD = 3.69), social functioning scoref (mean = 9.13; SD = 5.97) and school functioning scores (mean = 9.67; SD = 4.80) compared to patients with serum ferritin greater than 5,000 ng/ml.

## Discussion

As the focus of the study was to know the perceptions of thalassemic patients on their treatment regimen, the HRQoL scores obtained from the PedsQL questionnaire were examined. In contrast to previous studies [19, 20], treatment protocols, whether subcutaneous or oral were not a significant predictor of HRQoL. This non-significant relationship may be possible, as the questions used to assess the HRQoL of the patients were related to the feelings and conditions of the patients during the previous month. Only the general health functioning subscale score had a significant association with HRQoL, showing improved Quality of Life among patients treated with oral drugs. This is because most patients showed improved compliance with oral drug therapy.

As with the previous studies [17], age was a significant predictor of HRQoL, which coincides with our study depicting a significant association between age and Quality of Life. Patients less than 12 years of age showed better HRQoL compared to patients more than 12 years of age. This is due to social disruption, which leads to depression [28]. Based on our literature review, the limited previously available data showed that thalassemia is more prevalent in rural areas compared to urban areas [29]. Our results are the same, as patients who are residents of urban areas show improved HRQoL in the total summary score and in all other subscales except the general health score. Some studies [21, 30] show that elevated iron overload for a longer term may result in severe morbidity and mortality. In another study [30], a significant relationship between HRQoL and serum ferritin levels greater than 2,500 ng/ml was revealed. As with these findings, our study has shown a significant relationship between serum ferritin and HRQoL. Patients with serum ferritin greater than 5,000 ng/ml showed significantly improved HRQoL compared to patients with serum ferritin greater than 5,000 ng/dl. This conflicting finding could possibly be due to the fact that the long term Iron overload occurs gradually, so presentation of the elevated serum ferritin do not cause significant visible symptoms. It was also seen that long-term iron overload occurs gradually, and as such, the presentation of the elevated serum ferritin does not cause significant visible symptoms [31].

In β-thalassemia patients, renal tubular abnormalities might appear, which suggests that the damage might be caused by anaemia and increased oxidation induced by excess iron deposits [32]. In a previous study [33], the serum ferritin level is positively related with serum ALT, AST, ALP and MDA. It also showed that serum ferritin is an important parameter estimating the cellular damage in patients suffering from thalassemia [34]. In our study, a significant association of urea and AST with HRQoL has been shown (Table 4). In addition to the total summary score, patients who had urea levels higher than 20 mg/dl showed improved physical functioning, emotional functioning and general health scores. Patients who has AST levels higher than 56 mg/dl also showed improved HRQoL and emotional and school functioning scores.

### Limitations of the study

The major limitation in the recording of data was incomplete records and the absence of proper clinical reports for some patients. Another limitation is that the data was collected only from one centre, so it might not be representative of the entire population of thalassemia patients in Pakistan.

## Conclusions

Keeping in mind the current population in Pakistan, our study shows that factors like rural residence, inequality and clinical parameters, like serum ferritin, urea and AST, significantly affect the HRQoL of thalassemic patients, and this suggests that there is a need for improvement in thalassemia management. A modification of thalassemia-related healthcare services with a pragmatic approach can improve the levels of treatment outcome, thus improving health-related quality of life (HRQoL). Healthcare services can be modified by overcoming underuse, overuse and misuse of services and by controlling disparities in quality. In addition, a more effective and convenient regimen of iron chelation is essential to improve HRQoL.

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