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RESEARCH

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Evaluation of medication adherence and medication beliefs and their relation with quality of life in osteoporotic patients with and without vertebral fractures: a path analysis

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Abstract

Background Osteoporosis (OP) is a public health problem that causes morbidity and mortality with various complications, especially fractures, negatively affects quality of life (QoL) and creates an economic burden on society. The aim of this study was to investigate the relationships among medication adherence, medication beliefs, QoL in Turkish patients with OP.

Results The Medication Adherence Report Scale (MARS) total score was 17 in those with vertebral fractures and 18 in those without vertebral fractures. The total Quality of Life Questionnaire of the European Foundation for Osteoporosis (Qualeffo-41) score was 48.7 in those with vertebral fractures and 35.1 in those without vertebral fractures. Visual analog scale (VAS) of pain scores showed a moderate correlation with every domain of the Qualeffo-41 scores ($r = 0.401$, $r = 0.412$, $r = 0.391$, $r = 0.402$, $r = 0.380$, $r = 0.387$ respectively, $P = < 0.001$). MARS total score, Beliefs about Medicines Questionnaire (BMQ), and Qualeffo-41 parameters were compared between patients with osteoporotic fractures and without fractures. In patients with a vertebral fracture, the patients Qualeffo-41 scores were higher with every domain and their QoL was more impaired ($p < 0.001$); but there were no significant differences between patients with osteoporotic fractures and without fractures in terms of MARS total score and BMQ domains. The pathway analysis results showed that general beliefs about drugs is associated with the physical function and social function of statistically significant and general overuse is associated with the pain ($\beta = 1.781$; $p < 0.001$), and general health ($\beta = 1{,}832$; $p = 0.039$). However, self-reported medication adherence and specific beliefs is not associated with the pain, physical function, social function, general health, and mental function ($p > 0.05$) of statistically significant.

Conclusions Enhancing positive medication beliefs are a promising approach to improve medication adherence, and in turn, improved diseases self management and better QoL, in OP patients.

Keywords Osteoporosis, Vertebrae fracture, Medication adherence, Beliefs about medicines, Quality of life

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Background

Osteoporosis (OP) is defined as a systemic skeletal disease involving bone tissue. OP is an important public health problem that causes morbidity and mortality with various complications, especially fractures, affects

quality of life, and imposes an economic burden on society all over the world. According to the latest reports, the incidence of osteoporosis is 44.7% and the incidence of osteopenia is 18.5% in women aged 40–79 years [1–5]. More than one-third of middle-aged and elderly women in the world suffer from fractures due to the effects of osteoporosis [6]. Given the increasing life expectancy and aging population, the burden of OP and the annual prevalence of osteoporosis-related fractures are expected to increase over.

OP decreases the bone mass, structure, and strength and that results in an increased risk for fragility fracture. Osteoporosis-related fractures have an adverse impact on the patients' physical, mental, social, and emotional health and can cause significant consequences in patients such as limitations in activities of daily living, a decrease in well-being, social isolation, depression, and chronic pain. The goals of OP treatment is to preserve bone mass, prevent the development of fractures, and improve patient's QoL [7, 8]. World Health Organization (WHO) defines QoL as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns [9]. The effectiveness of OP treatment depends on the drug potency, the patient's belief about the drug and treatment adherence. WHO defines treatment adherence as the internalization of general or medical health recommendations, taking prescribed medicines in appropriate dose and frequency, adaptation to diet and health recommendations, and maintaining lifestyle changes by patients. Medication adherence is defined as 'the process by which patients take their medications as prescribed, composed of initiation, implementation and discontinuation. Treatment adherence is an important factor for symptom control and treatment success during the management of chronic diseases. Poor medication adherence compromises the effectiveness of therapeutic regimens. Unfortunately, worldwide, adherence to long-term medications remains a challenge and is less than 50%; in developing countries, medication adherence is even more challenging [9–13]. Nonadherence to drug therapy in the adult population has been associated with patient- and drug-related factors; for example, gastroesophageal or others side effects of the medication, duration of therapy, socioeconomic factors referring to medication cost, health insurance, and family or social support. Additionally, "health literacy" defined as the degree to which an individual has the capacity to obtain, process, and understand basic health information to comply with treatment and make appropriate health decisions about his/her health, and thus is considered as a key point contributing to medication adherence [14, 15]. It has been shown that OP drugs are effective in reducing fracture risk, but adherence are not optimal [16, 17]. Specifically, nonadherence to the recommended treatment is linked with increased fracture risk, hospitalization, morbidity, and mortality [18].

The goal of this study was to investigate the relationships among medication adherence, medication beliefs, QoL in Turkish patients with OP. To our knowledge, no studies have assessed medication adherence and beliefs about medicines in patients with osteoporosis in a Turkish sample of adults with OP.

Methods

Study design

This study was cross-sectional and descriptive. Data collection occured between March 2021 and December 2021. The study setting was outpatient clinic tertiary hospital. A convenience sample (n = 145) was obtained who were admitted to outpatient clinic of physical medicine and rehabilitation. Inclusion criteria were (i) diagnosis of primary OP, (ii) consistent medications regularly for at least 12 months with no changes to medication type or dose (iii) being able to read and write fluently in Turkish, and (iv) provide informed consent. The exclusion criteria were (i) patients not taking medication or '"lost to follow-up"' for osteoporosis (defined as no visit to the outpatient clinic within the last 12 months), (ii) those with secondary OP, (iii) metabolic bone diseases other than OP (e.g., Paget's disease, osteomalacia, or renal osteodystrophy), (iv) bone metastasis and hypogonadism, (v) any diagnosis of psychiatric disorders and receiving psychiatric treatments or cognitive dysfunctionsincluding dementia, (vii) patients who are on hormonal drugs, (viii) pregnant and post-partum women. The sampling frame osteoporotic patients. Of these, patients with or without osteoporotic vertebrae fractures were approached for participation, patients were screened out by study inclusion/exclusion; and of those appraoched, 88.4% patients were included in the final sample.

Ethical statement

University Institutional Review Board approval was obtained for the study (Decision no: 2021/63; date: March 1, 2021). Prior to the evaluation, the patients, as appropriate, were given verbal and written information on the nature of the study. Informed consent forms were signed upon admission to the trial. All procedures performed in studies with human participants met the ethical standards of the Institutional Research Commission and the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

Data collection procedure

Data collection occured in-person, at one time point in outpatient clinic of physical medicine and rehabilitation. Data collection procedure was carried out by the same physician via the survey and the questionnaires. Patients who met inclusion and exclusion criteria and agreed to participate to enrollment study were completed surveys that catpured sociodemographic information (gender, age, body mass index (BMI), educational status, marital status, occupational status, place of residence). For each patient included, the physician noted the medical comorbidities, duration of osteoporosis, current use of anti-osteoporotic medications, fracture history, dorsal and lumbar back pain. Participants self-reported dorsal and lumbar back pain using the visual analog scale (VAS; 0-10 cm; "0" indicates no pain, "10" indicates severe pain). If the patients had fracture history or dorsal and lumbar back pain, patients' dorsal and lumbar anteroposterior and lateral radiographs were examined to determine vertebral compression fractures by the same physician. Patient's vertebrae were evaluated by semiquantitative method (Genant-vertebral morphometry) in the anteropasterior and lateral thoracic and lumbar radiographs (T4-L5) to determine vertebral compression fractures. If at least one of the three height measurements of a vertebra decreased by 20% from the height measurement of the nearest normal vertebra, it was considered as a fracture [19]. A diagnosis of osteoporosis was based on bone mineral density measurements (BMD) and it was assessed using the dual energy X-ray absorptiometry (DXA).The patients with a T score of − 2.5 standard deviation (SD) and below were defined as having OP, between − 1 and − 2.5 SD as having osteopenia (low bone density), and − 1 SD and above as normal [20]. The lumbar vertebrae (in the anterior position between L1-L4) and femur neck T scores with in the last year were recorded.

Assessment of quality of life

We used a 41-item Quality of Life Questionnaire of the European Foundation for Osteoporosis (Qualeffo-41) for assessment of quality of life, which has a valid and reliable form in Turkish. The Qualeffo-41 is composed of 41 questions and separate subscales for pain (5 items), physical function (17 items), social activities (7 items), general health perception (3 items), and mental function (9 items). Qualeffo-41 has a total score. The total score is from 1 to 100. Higher scores indicate increasing severity and reflect a lower QoL [21, 22]. In the reliability studies for the Turkish version of Qualeffo-41, Cronbach's a was calculated for each domain and values between 0.70 and 0.96 were obtained [21]. The internal consistency coefficient in this study were similar to those in the original version. The Qualeffo-41 showed good internal consistency across study group with Cronbach's α-coefficients of .95.

Assessment of medication beliefs and medication adherence

The Turkish version of the Beliefs about Medicines Questionnaire (BMQ) was used to assess the treatment beliefs of the patients with osteoporosis. The BMQ is an 18-item questionnaire presented in two parts (general and specific beliefs about the concerned drug) and four scales: The BMQ-Specific necessity (patients' beliefs about the necessity of the prescribed medication for controlling their illness), the BMQ Specific-concerns (patients' concerns about the potential adverse effects of taking medication), the BMQ General-overuse (scoring the statement that medicine is overused), and the BMQ General-harm (scoring beliefs that medication is harmful and poisonous). Each question is scored based on a five-point Likert scale (1—strongly disagree; 2—disagree, 3—uncertain, 4—agree, 5—strongly agree, and 5—strongly agree). The scale of specific beliefs have five questions ranging from 5 to 25. Higher scores in the Specific-Necessity Subscale indicate stronger perceived benefits of use the prescribed drug to maintain health compared to personal needs. Higher scores in the Specific-Concerns Subscale indicate greater concern about the adverse effects of regular drug use. In the general beliefs scale, the harm and overuse subscales have five questions each, scored from 4 to 20, with higher scores in the former indicating a more negative point of view about drugs in general terms, and considering drugs as addictive and toxic substances, and higher scores in the latter representing more negative views of the way doctors prescribe drugs. A high score on each dimension indicates a negative perception of drugs in general. The necessity-concerns differential (necessity beliefs) is calculated as the difference between the scores of the necessity and the concern scales. This differential can be thought of as an indicator of how the individual judges their personal need for the treatment relative to their concerns about taking medicine [23, 24]. The internal consistency coefficient in this study were similar to those in the original version. The BMQ showed good internal consistency across study group with Cronbach's α-coefficients of .71.

The current study was used the Turkish version of Medication Adherence Report Scale (MARS) to assess the medication adherance patients with osteoporosis. MARS was previously validated to measure treatment

adherence for all chronic diseases requiring long-term medication. This is a five-item structured questionnaire designed to assess a range of nonadherent behaviors, including the tendency to avoid, forget or stop taking medication and the tendency to adjust or change the dose prescribed by the physician. Unlike other medication adherence scales with dichotomous responses, the number of items and range of response options in MARS highlights the dynamic pattern of the medication adherence phenomenon. The items of the scale are to be answered on a five-point Likert scale ranging from (1) "(always)" to (5) "(never)." The cumulative score of MARS ranges from 5 to 25. A higher score on MARS indicates a higher level of self-reported adherence to the corresponding medication and a decrease in score on MARS indicates incompatibility [25, 26]. The internal consistency coefficient (.78) and overall item correlations (ranging from .35 to .71) in this study were similar to those in the original version. The internal consistency coefficient (Cronbach α) was also calculated using the baseline data. The MARS showed good internal consistency across study group with Cronbach's α-coefficients of .93.

Sample size

The sample size was calculated using the program G*power (V3.1.9.2), with a minimum sample size of 111 participants at an $\alpha = 0.05$ and a power of 95% [27, 28].

Statistical analysis

Data were analyzed using IBM SPSS V23. Conformity to normal distribution was tested using the Kolmogorov-Smirnov test. Mann-Whitney *U* test and Kruskal-Wallis's test were used. Pearson correlation coefficient was used to analyze the relationship between normally distributed scales, and Spearman's rho correlation coefficient was used to analyze the relationship between non-normally distributed scales. Analysis results were presented as mean±SD and median (minimum-maximum) for quantitative data. Including factors and their hypothetical pathways were based on the literature review and consultation with specialists. We designed a path model where the patients' medication adherence and bliefs about medicines would directly affect QoL of osteoporosis patients, and the relationship between Qualeffo-41 and BMQ and MARS was examined using Path analysis. Statistical significance was set at $P \leq 0.05$.

Results

This study followed STROBE guidelines for conducting and reporting observational studies. STROBE guidelines is for reporting the observational studies. The participant recruitment scheme is shown in Fig. 1.

Of the 145 participants, 86% were female, and14% were male. The mean age was 68.92 (SD=9.96) years. The mean time from initial primary OP diagnosis was 4.07 (SD = 3.5)

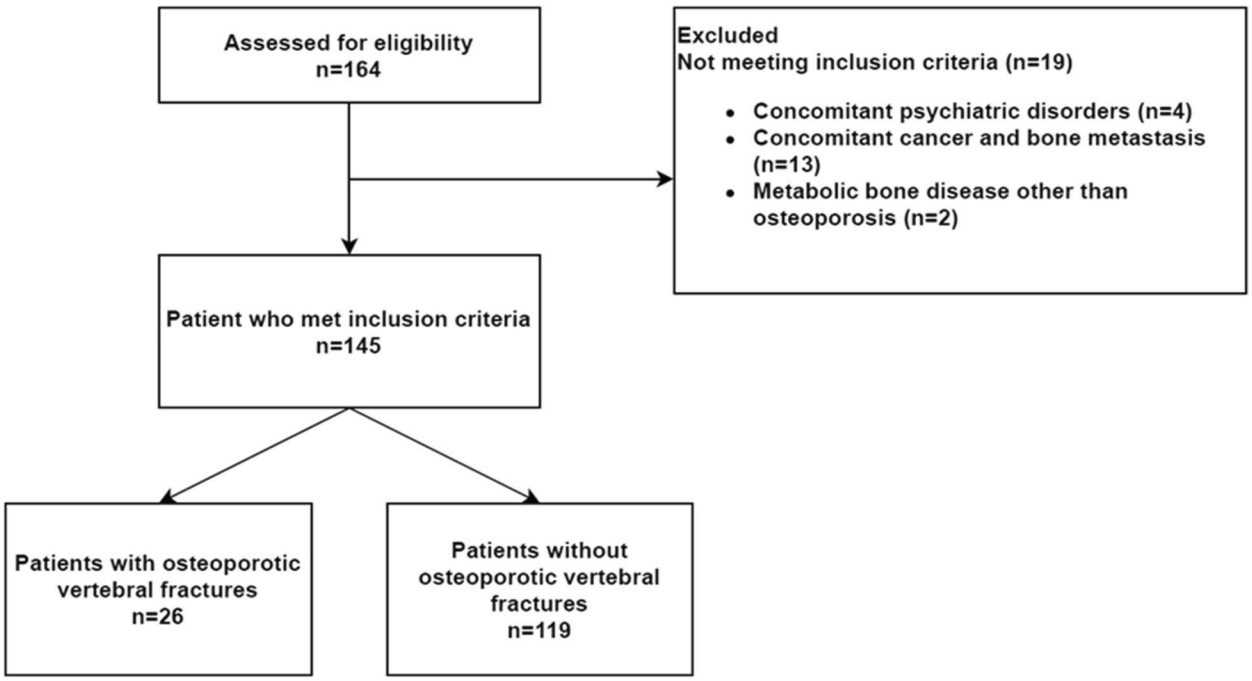

Fig. 1 The participant recruitment scheme

Table 1 Comparison of the demographic characteristics of the patients with the parameters of the Qualeffo-41 scale

	Pain	Physical function	Social function	General health perception	Mental function	Total
Gender						
Female	28.6 (19.4–39.6)	26.1 (18.4–44.4)	55.4 (44.9–78.8)	50.5 (40.8–73.9)	39.4 (29.1–59.8)	36.5 (24.6–56.8)
Male	28.75 (20.6–36.8)	24.9 (18.2–46.4)	55.4 (46.6–78.4)	51.1 (41.6–73.7)	39.4 (30.2–59.2)	36.8 (27.1–57.1)
Test statistic[a]	1175.0	1136.5	1246.0	1196.0	1237.5	1222.5
p	0.667	0.515	0.982	0.757	0.943	0.875
Marital status						
Married	28.6 (19.4–39.6)	26.1 (18.6–42.5)	55.8 (44.9–76.4)	50.8 (40.8–71.8)	40.5 (29.1–58.1)	36.8 (24.6–55.4)
Single	30.4 (25.4–37.8)	28.6 (22.6–39.6)	58.2 (52.6–76.5)	53.3 (48.9–71.1)	41.9 (36.9–59.1)	39.2 (33.4–56.8)
Divorced/widowed	28.2 (20.4–36.8)	25 (18.2–46.4)	53.35 (46.6–78.8)	48.5 (41.5–73.9)	38.2 (30.7–59.8)	35.95 (26.8–57.1)
Test statistic[b]	1.980	1.648	3.390	2.940	3.836	2.479
p	0.372	0.439	0.184	0.230	0.147	0.289
Education level						
Illiterate	27.6 (19.4–38.4)	24.7 (18.6–42.4)	52.4 (44.9–69.8)	47.8 (40.8–64.8)	37.8 (29.4–54.7)	35.7 (25.4–52.6)
Literate	27.9 (20.4–39.6)	25.1 (18.4–41.8)	55.35 (46.7–74.8)	50.7 (41.2–69.7)	38.4 (29.1–59.2)	35.4 (27–57.1)
Primary-middle school	29.4 (22.4–36.8)	27.3 (19.4–46.4)	55.7 (46.8–78.8)	50.5 (42.1–73.9)	40.5 (30.8–59.8)	38.4 (24.6–56.1)
High school	29.4 (22.6–38.6)	26.25 (19.4–44.4)	56.8 (47.8–76.4)	52.35 (42.9–71.8)	41.4 (30.2–58.1)	38.45 (27.5–55.1)
University	28.6 (20.6–37.8)	25.4 (18.2–40.2)	58.2 (46.6–76.5)	53.1 (41.6–71.1)	41.8 (30.8–59.1)	36.8 (27.1–56.8)
Test statistic[b]	7.081	5.183	7.363	7.234	4.907	4.409
p	0.132	0.269	0.118	0.124	0.297	0.353

$P \leq 0.05$

[a] Mann-Whitney *U* test

[b] Kruskal-Wallis H test; median (minimum-maximum); *Qualeffo-41* Quality of Life Questionnaire of the European Foundation for Osteoporosis

years. The majority of patients, 63%, had comorbidities. The most common was hypertension, 48%.

As shown in Tables 1 and 2, there were no differences in demographic characteristics of the participants on sub-parameters of the Qualeffo-41 scale. The median values of the sub-parameters of the Qualeffo-41 scale did not differ. There were differences on median values of pain, social function, general function and mental function, which are sub-parameters of the Qualeffo-41 scale, by gender, marital status, educational status, occupation and accompanying person according to the place of residence (rural or urban) ($p = 0.036$; $p = 0.014$; $p = 0.016$; $p = 0.028$, respectively). Median values of physical function and total score did not differ according to the place of residence (Tables 1 and 2).

The sub-parameters of the BMQ scale were compared according to the demographic characteristics of the patients and are shown in Table 3. The median values of BMQ subparameters did not differ according to demographic characteristics. However, the median value of the specific anxiety subparameter differed according to marital status ($p = 0.015$) (Table 3).

The pain severity was evaluated using the VAS. The correlations between the pain measurement and QoL were analyzed, and VAS scores showed a moderate correlation with every domain of the Qualeffo-41 scores ($r = 0.401$, $r = 0.412$, $r = 0.391$, $r = 0.402$, $r = 0.380$, $r = 0.387$ respectively). Also, a statistically significant relationship was found between VAS and Qualeffo-41 scores ($p < 0.001$) (Table 4).

One hundred nineteen patients (82.1%) had no vertebral fractures. But 26 patients (17.9%) had one or more vertebral fractures according to the anteroposterior and lateral thoracic and lumbar radiographs. Patients' demographic and clinical parameters according to presence of vertebral fractures compared. There was no significant difference among the groups ($p > 0.05$) (Table 5).

MARS total score, BMQ, and QoL parameters according to presence of vertebral fractures compared. In patients with a vertebral fracture, the patients Qualeffo-41 scores were higher with every domain and their QoL was more impaired ($p < 0.001$). However, there were no significant differences between groups in terms of MARS total score and BMQ domains ($p > 0.05$) (Table 6).

In our study, we designed a path model to analyze how treatment adherence and beliefs about drugs affect the QoL of osteoporosis patients. We designed a path model where the patients' medication adherence and medication

Table 2 Comparison of the demographic characteristics of the patients with the parameters of the Qualeffo-41 scale

	Pain	Physical function	Social function	General health perception	Mental function	Total
Occupational status						
Employee	29.4 (22.4–32.8)	26.4 (22.6–36.4)	56.8 (50.2–64.8)	52.3 (42.9–59.4)	41.6 (30.2–47.2)	38.5 (27.5–44.6)
Housewife	28.4 (19.4–39.6)	25.65 (18.4–44.4)	55.05 (44.9–78.8)	49.6 (40.8–73.9)	38.65 (29.1–59.8)	36.2 (24.6–56.1)
Retired	26.4 (20.6–31.4)	23.8 (18.2–34.8)	52.6 (46.6–67.8)	47.1 (41.6–62.8)	35.9 (30.8–49.5)	33.6 (27.1–47.2)
Engineer	34.75 (32.7–36.8)	42.9 (39.4–46.4)	76.6 (74.8–78.4)	71.7 (69.7–73.7)	57.15 (55.1–59.2)	54.65 (52.2–57.1)
Teacher	28.9 (28.9–28.9)	24.6 (24.6–24.6)	69.7 (69.7–69.7)	68.1 (68.1–68.1)	56.1 (56.1–56.1)	52.1 (52.1–52.1)
Accountant	30.8 (27.6–36.4)	27.6 (24.8–40.2)	58.3 (49.8–69.4)	53.3 (44.6–64.2)	41.8 (32.8–52.8)	39.2 (28.1–47.2)
Unemployed	37.8 (37.8–37.8)	39.6 (39.6–39.6)	76.5 (76.5–76.5)	71.1 (71.1–71.1)	59.1 (59.1–59.1)	56.8 (56.8–56.8)
Test statistic[b]	7.363	8.945	10.426	10.142	9.396	9.048
p	0.195	0.111	0.064	0.071	0.094	0.107
Place of residence						
Rural	27.6 (20.6–39.6)	25.1 (18.2–41.8)	53.4 (46.6–74.6)	48.4 (41.2–69.1)	38.1 (29.9–57.5)	35.7 (26.8–55.4)
Urban	28.9 (19.4–38.6)	26.2 (18.6–46.4)	56.8 (44.9–78.8)	52.3 (40.8–73.9)	40.9 (29.1–59.8)	38.4 (24.6–57.1)
Test statistic[a]	1938.000	2012.000	1849.000	1859.500	1911.500	1973.000
p	**0.036**	0.073	**0.014**	**0.016**	**0.028**	0.051
Accompanying person						
Alone	28.2 (20.6–37.8)	25.4 (18.2–44.4)	55.6 (46.6–76.5)	50.5 (41.6–71.1)	38.6 (29.1–59.1)	36.2 (26.8–56.8)
Family members	28.6 (19.4–39.6)	26 (18.4–43.8)	55.4 (44.9–78.8)	50.15 (40.8–73.9)	39.3 (29.4–59.8)	36.55 (24.6–56.1)
Caregiver	28.9 (22.4–38.4)	26.75 (19.4–46.4)	56.1 (48.6–78.4)	52.25 (43.9–73.7)	40.35 (31.8–59.2)	37.05 (28.6–57.1)
Test statistic[b]	0.580	0.869	1.244	1.436	0.412	0.382
p	0.748	0.648	0.537	0.488	0.814	0.826

$P \leq 0.05$

[a] Mann-Whitney *U* test

[b] Kruskal-Wallis H test; median (minimum-maximum); *Qualeffo-41* Quality of Life Questionnaire of the European Foundation for Osteoporosis

bliefs would directyl affect QoL of osteoporosis patients. Path analysis was utilized to determine the factors affecting QoL and the magnitude of the effects of each variable. The magnitude of each effect was presented with standard regression coefficient and non-standard regression coefficient. Therefore hypothesized relations among constructs in our proposed model was tested using path analysis. With the path analysis model created, MARS was designed to examine the effects of specific necessity, specific concerns, general harm, and general overuse parameters on pain, physical function, social function, general health perception, and mental function. There are six variables in this hypothesized model and with the independent variable, 14.6% of pain, 9% of physical function, 6.8% of social function, 6.4% of general health, and 3.4% of mental function can be explained.

The beliefs about medicines questionnaire is a tool that measures how individuals conceptually evaluate the drugs prescribed to them. The general-overuse dimension assesses how patients perceive the extent of drug use, and the overall-harm dimension is demonstrate their beliefs about the harmful nature of the drug. As hypothesized, the path coefficient between the general harm dimension and physical function proved to be statistically significant. As general harm increased, the physical function score decreased by 1.316 points ($\beta = -1.316$; $p = 0.035$). The path coefficient between the general harm dimension and social function proved to be statistically significant and with increasing general harm, the score for social function decreased by 1.597 points ($\beta = -1.597$; $p = 0.040$). The path coefficients between MARS, pain, physical function, social function, general health, and mental function of the specific necessity and specific concerns dimensions were not statistically significant ($p > 0.05$). The path coefficient between general harm and pain, general health and mental function was not significant ($p > 0.05$). As general overuse increased, the pain score increased by 1.781 units ($\beta = 1.781$; $p < 0.001$). With increasing general overuse, the physical function score increased by 1.968 units ($\beta = 1.968$; $p = 0.005$). As general overuse increased, while the score for social function increased by 1.937 units ($\beta = 1.937$; $p = 0.027$), the general health score increased by 1.832 units ($\beta = 1.832$; $p = 0.039$). The path coefficient between general overuse and mental function was not significant (Table 6; Figs. 2 and 3).

Table 3 Comparison of the demographic characteristics of the patients with the parameters of the BMQ scale

	Spesific necessity	Spesific concerns	General harm	General overuse
Gender				
Female	2.2 (1.2–3.6)	2.4 (1.6–3.4)	3.3 (2–4.3)	2.3 (1.5–4.3)
Male	2.2 (2–4)	2.2 (2–3.4)	3.3 (2.3–4.8)	2.3 (1.8–3)
Test statistic[a]	216.0	233.0	223.0	199.0
p	0.507	0.773	0.618	0.343
Marital status				
Married	2.2 (1.8–4)	2.4 (1.6–3.4)	3.3 (2.3–4.8)	2.3 (1.5–4.3)
Single	2.4 (2.2–3.6)	2.7 (2.4–3)	3.3 (3.3–4.3)	2.4 (1.8–4.3)
Divorced/widowed	2.2 (1.2–3)	2.2 (1.8–3.4)	3.8 (2–4.3)	2.5 (1.8–3.8)
Test statistic[b]	4.921	8.363	0.124	4.351
p	0.085	**0.015**	0.940	0.114
Education level				
Illiterate	2.2 (1.2–2.4)	2.2 (1.8–3.4)	3.8 (2.5–4.3)	2.5 (1.8–3.8)
Literate	2.2 (1.8–2.4)	2.3 (1.6–3.4)	3.3 (2.3–3.8)	2.3 (1.5–3)
Primary-middle school	2.2 (2–4)	2.5 (2.2–3.4)	3.5 (3–4.8)	2.1 (1.8–3)
High school	2.2 (2–3)	2.4 (2–3.4)	3.3 (2–4.3)	2.4 (1.8–4.3)
University	2.2 (2–3.6)	2.2 (2.2–3.4)	3.8 (3–4.3)	2.3 (1.8–4.3)
Test statistic[b]	4.453	4.702	1.272	5.479
p	0.348	0.319	0.866	0.242
Occupational status				
Employee	2.4 (2.2–4)	2.4 (2–2.8)	3.8 (2.3–4.8)	2.8 (1.8–4)
Housewife	2.2 (1.2–3)	2.3 (1.6–3.4)	3.3 (2–4.3)	2.3 (1.5–4.3)
Retired	2.2 (2–2.4)	2.2 (2.2–2.2)	3.4 (2.6–3.8)	2.1 (1.8–2.5)
Engineer	2.2 (2.2–2.2)	3.4 (3.4–3.4)	3.3 (3.3–3.3)	1.8 (1.8–1.8)
Teacher	2.2 (2–2.6)	2.2 (2.2–2.8)	3.8 (3.3–3.8)	2.5 (1.8–3)
Accountant	3.6 (3.6–3.6)	2.6 (2.6–2.6)	4.3 (4.3–4.3)	4.3 (4.3–4.3)
Test statistic[b]	3.531	4.374	1.924	3.261
p	0.473	0.358	0.750	0.515
Place of residence				
Rural	2.2 (1.2–2.6)	2.4 (2–3.4)	3.3 (2.5–4.8)	2.3 (1.8–3.8)
Urban	2.2 (1.8–4)	2.2 (1.6–3.4)	3.3 (2–4.3)	2.3 (1.5–4.3)
Test statistic[a]	415.0	402.5	415.5	409.0
p	0.569	0.470	0.588	0.538
Accompanying person				
Alone	2.2 (2.2–3.6)	2.8 (2–3.4)	3.3 (2.6–4.3)	2 (1.5–4.3)
Family members	2.2 (1.2–4)	2.2 (1.6–3.4)	3.8 (2–4.8)	2.3 (1.8–4.3)
Caregiver	2.2 (2–2.4)	2.2 (2.2–2.2)	3.8 (3–3.8)	2.5 (1.8–2.5)
Test statistic[b]	1.190	4.342	0.398	1.034
p	0.552	0.114	0.820	0.596

$P \leq 0.05$

[a] Mann-Whitney *U* test

[b] Kruskal-Wallis *H* test; median (minimum-maximum); *BMQ* Beliefs about Medicines Questionnaire

Discussion

Medication adherence is an important factor that determines the success and effectiveness of treatment and plays a role in increasing quality of life. It is well known that adherence to prescription drugs is low in people with chronic diseases [29]. In our study examining drug adherence, beliefs about the drug, and QoL in patients with osteoporosis, it was found that all subparameters of the Qualeffo-41 scale had a positive moderate correlation with VAS and QoL

Table 4 Correlations of pain with quality of life parameters

Qualeffo-41	Pain VAS	
	r	*p*
Pain	0.401	< 0.001[a]
Physical function	0.412	< 0.001[b]
Social function	0.391	< 0.001[b]
General health perception	0.402	< 0.001[b]
Mental function	0.380	< 0.001[b]
Total	0.387	< 0.001[b]

$P \leq 0.05$

[a] Pearson correlation analysis

[b] Spearman rho correlation analysis; *r* correlation coefficient, *Qualeffo-41* Quality of Life Questionnaire of the European Foundation for Osteoporosis, *VAS* visual analog scale

was negatively affected in patients with osteoporotic vertebral fractures; moreover, we found that drug adherence and beliefs about the drug did not differ significantly between patients with and without fractures. The pathway analysis results showed that general beliefs about drugs mediated physical function and social function, and that general overuse mediated pain and general health. However, self-reported medication adherence and specific beliefs did not mediate the relationship between pain, physical function, social function, general health, and mental function.

OP is one of the most frequent metabolic bone disorders worldwide, and it has been defined as a silent skeletal disorder that does not display any evidence of disease until a fracture occurs. OP affects the bone mass, structure, and strength and that results in an increased risk of fragility fracture. It is well known that; OP is an important public health problem that causes morbidity and mortality with various complications, affects QoL [3, 30]. Health-related QoL is the health status that can be primarily affected by clinical practices among all QoL parameters of individuals. Therefore, it is crucial to consider QoL when planning chronic disease treatment [31]. Many factors can affect the QoL of OP patients. The QoL assessment is important in determining clinical treatment strategies and assessing treatment effectiveness [32]. Because QoL scores may be low in osteoporosis patients without fractures, the Qualeffo-41 scale has also been recommended for osteoporosis patients without vertebral fractures [33]. Studies reporting the impact of vertebral fractures on QoL have emphasized that physical, emotional, and psychological disability, along with pain caused by fractures, affect QoL [31–34]. Our study found that the QoL of patients without fracture was also affected, which is consistent with the results of previous studies, but this effect was greater in patients with fractures. When examining the effects of sociodemographic characteristics on the subparameters of

Table 5 Comparison of patients' demographic, clinical parameters, and scales according to presence of vertebral fractures

	Vertebral fracture		Test statistic[a]	*P*
	Yes (*n* = 26)	No (*n* = 119)		
Age (year)	69 (49–84)	68 (40–89)	1462.0	0661
Body mass index (kg/m^2)	30.7 (17.3–31.4)	27.6 (3–37)	1457.0	0.643
Disease duration (year)	3 (1–12)	3 (1–15)	1426.0	0.526
BMD (L1-L4) T score	– 2.7 (– 6.2 to – 0.1)	– 2.6 (– 4.8–0.7)	1321.0	0.244
BMD (femur neck) T score	– 2.6 (– 4.2 to – 0.7)	– 2.6 (– 4.4–2.8)	1392.5	0.425
MARS Total	17 (9–25)	18 (2–25)	1371.5	0.364
BMQ-Spesific necessity	2.5 (1.2–4)	2.2 (1.2–4.6)	1383.0	0.384
BMQ-Specific concerns	2.2 (1.2–3.8)	2.2 (1.2–3.4)	1219.0	0.087
BMQ-General harm	3.1 (1.8–4.3)	3.3 (1.5–4.8)	1294.0	0.181
BMQ-General overuse	2.3 (1–4.3)	2.3 (1–4.3)	1521.5	0.894
Qualeffo-41 Pain	34.1 (24.9–39.6)	27.9 (19.4–33.8)	353.5	< 0.001
Qualeffo-41 Physical function	39.5 (25.9–46.4)	24.8 (18.2–36.4)	95.5	< 0.001
Qualeffo-41 Social function	69.7 (56.4–78.8)	53.4 (44.9–69.7)	72.5	< 0.001
Qualeffo-41 General health perception	64.8 (50.9–73.9)	48.7 (40.8–68.1)	90.5	< 0.001
Qualeffo-41 Mental function	52.7 (41.6–59.8)	37.8 (29.1–56.1)	100.0	< 0.001
Qualeffo-41 Total	48.7 (38.5–57.1)	35.1 (24.6–52.1)	118.0	< 0.001

$P \leq 0.05$

[a] Mann-Whitney *U* test; median (minimum-maximum); *BMD* bone mineral density, *MARS* Medication Adherence Report Scale, *BMQ* Beliefs about Medicines Questionnaire, *Qualeffo-41* Quality of Life Questionnaire of the European Foundation for Osteoporosis

Table 6 Path analysis results

Dependent variable		Independent variable	β_0	β_1	SE	Test statistic	*p*
Pain[1]	<---	MARS	− 0.138	− 0.111	0.062	− 1.790	0.073
Physical function[2]	<---	MARS	− 0.051	− 0.059	0.093	− 0.635	0.525
Social function[3]	<---	MARS	− 0.013	− 0.018	0.116	− 0.156	0.876
General health perception[4]	<---	MARS	− 0.004	− 0.006	0.118	− 0.055	0.956
Mental function[5]	<---	MARS	0.039	0.055	0.116	0.479	0.632
Pain	<---	Spesific necessity	− 0.016	− 0.093	0.463	− 0.202	0.840
Physical function	<---	Spesific necessity	0.020	0.177	0.695	0.255	0.799
Social function	<---	Spesific necessity	0.044	0.474	0.866	0.547	0.584
General health perception	<---	Spesific necessity	0.068	0.736	0.875	0.841	0.401
Mental function	<---	Spesific necessity	0.047	0.491	0.861	0.570	0.568
Pain	<---	Specific concerns	− 0.137	− 0.994	0.559	− 1.780	0.075
Physical function	<---	Specific concerns	− 0.097	− 1.022	0.839	− 1.218	0.223
Social function	<---	Specific concerns	0.086	1.122	1.045	1.073	0.283
General health perception	<---	Specific concerns	0.092	1.209	1.056	1.144	0.253
Mental function	<---	Specific concerns	0.077	0.973	1.039	0.936	0.349
Pain	<---	General harm	− 0.147	− 0.795	0.416	− 1.910	0.056
Physical function	<---	General harm	− 0.167	− 1.316	0.625	− 2.105	0.035
Social function	<---	General harm	− 0.165	− 1.597	0.779	− 2.050	0.040
General health perception	<---	General harm	− 0.153	− 1.492	0.787	− 1.895	0.058
Mental function	<---	General harm	− 0.104	− 0.982	0.775	− 1.268	0.205
Pain	<---	General overuse	0.293	1.781	0.468	3.803	< 0.001
Physical function	<---	General overuse	0.222	1.968	0.704	2.797	0.005
Social function	<---	General overuse	0.178	1.937	0.877	2.209	0.027
General health perception	<---	General overuse	0.167	1.832	0.886	2.068	0.039
Mental function	<---	General overuse	0.117	1.240	0.872	1.423	0.155

$P \leq 0.05$; The hypothesized relationships between medication adherance, medication bliefs and health-related quality of life of patients with OP. [1]$R^2 = 0.146$; [2]$R^2 = 0.090$; [3]$R^2 = 0.068$; [4]$R^2 = 0.064$; [4]$R^2 = 0.034$; β_0 standard regression coefficient; β_1 non-standard regression coefficient, *SE* standard error, *MARS* Medication Adherence Report Scale

the Qualeffo-41 scale, we concluded that only place of residence (rural/urban) affected the subparameters of pain, social function, general health perception, and mental function; QoL scores were higher in those who lived in urban areas.

The causes of nonadherence to drug therapy depend on the interaction of multiple factors, suggesting the need for multifactorial and individualized solutions. In osteoporosis patients, nonadherence is associated with an increased risk of fracture and a negative impact on quality of life. Patients' knowledge and perceptions about the disease, as well as their beliefs about drugs, are also an important factor for drug adherence in osteoporosis treatment. Drug nonadherence remains a major problem in many chronic diseases, including osteoporosis [35]. The literature has investigated the beliefs about drugs and the drug adherence of patients with chronic diseases. In a study conducted with patients with type 2 diabetes mellitus, drug adherence was associated with stronger beliefs about the need for drugs, lower concerns about drugs, and lower beliefs about their harmful effects [36].

Low belief that using drugs can prevent fractures and increase the QoL of osteoporosis patients may make people more likely to neglect treatment. Low belief in the need for drugs may therefore lead patients to continue treatment with lower drug adherence. In addition, an appropriate patient-physician relationship characterized by mutual trust and meaningful interaction may help improve treatment beliefs and drug adherence [37, 38]. In our study, path analyzes were conducted between self-reported medication adherence, general and specific beliefs about drugs, pain, physical function, social function, general health, and mental function. Results showed that general beliefs about drugs affected physical and social function, pain, and general health, and that QoL parameters were significantly impaired in patients with stronger general

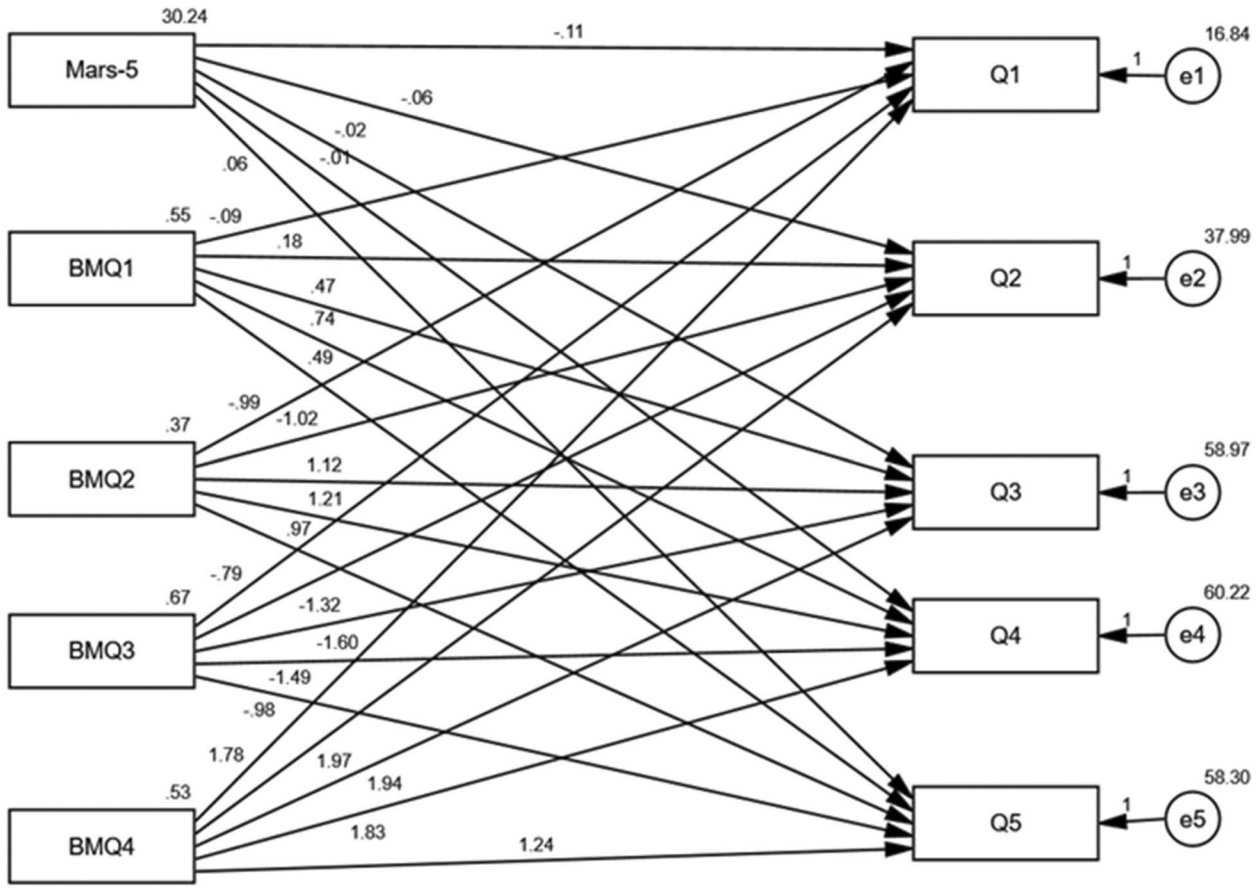

Fig. 2 Path analysis diagram and non-standard path coefficients; MARS: Medication Adherence Report Scale; BMQ: Beliefs about Medicines Questionnaire; Q: Quality

beliefs about the need for their drugs. Because of general beliefs about drugs, patients were aware that their QoL would be impaired if they did not use their drugs. Therefore, it is conceivable that patients who believe that the disease may have a greater impact on their QoL may be more likely to adhere to drugs to prevent or reduce short- and long-term consequences.

Study limitations

The present study has some limitations. First, all compliance-related outcomes and medication bliefs are based on patients' self reports. Self adminstrated questionnaires, as an indirect method, have the advantage of being an easy, cheap, and quick method [39]. In our study, adherence and bliefs about medication were only measured by self adminstrated questionnaires. Questionnaire used for data collection could have overestimated patients' responses and the patients' desire to please the interviewer. Therefore, preferably a combination of methods to measure adherence (e.g., self adminstrated questionnaire, pill count, refill adherence, medication event monitoring systems, and/or biochemical testing) should be used [40]. Furthermore, the study was conducted in a single centre, which may limit the generalizability of the study findings.

Conclusions

In this study, results showed that QoL was negatively affected in patients with osteoporotic vertebral fractures. It was resulted that drug adherence and beliefs about the drug did not differ significantly between patients with and without fractures. General beliefs about drugs mediated physical function and social function, and that general overuse mediated pain and general health. However, self-reported medication adherence and specific beliefs did not mediate the relationship between pain, physical function, social function, general health, and mental function. Therefore, positive medication beliefs might improve medication adherence, which in turn might lead to improved disease control and better QoL. Patients who believe

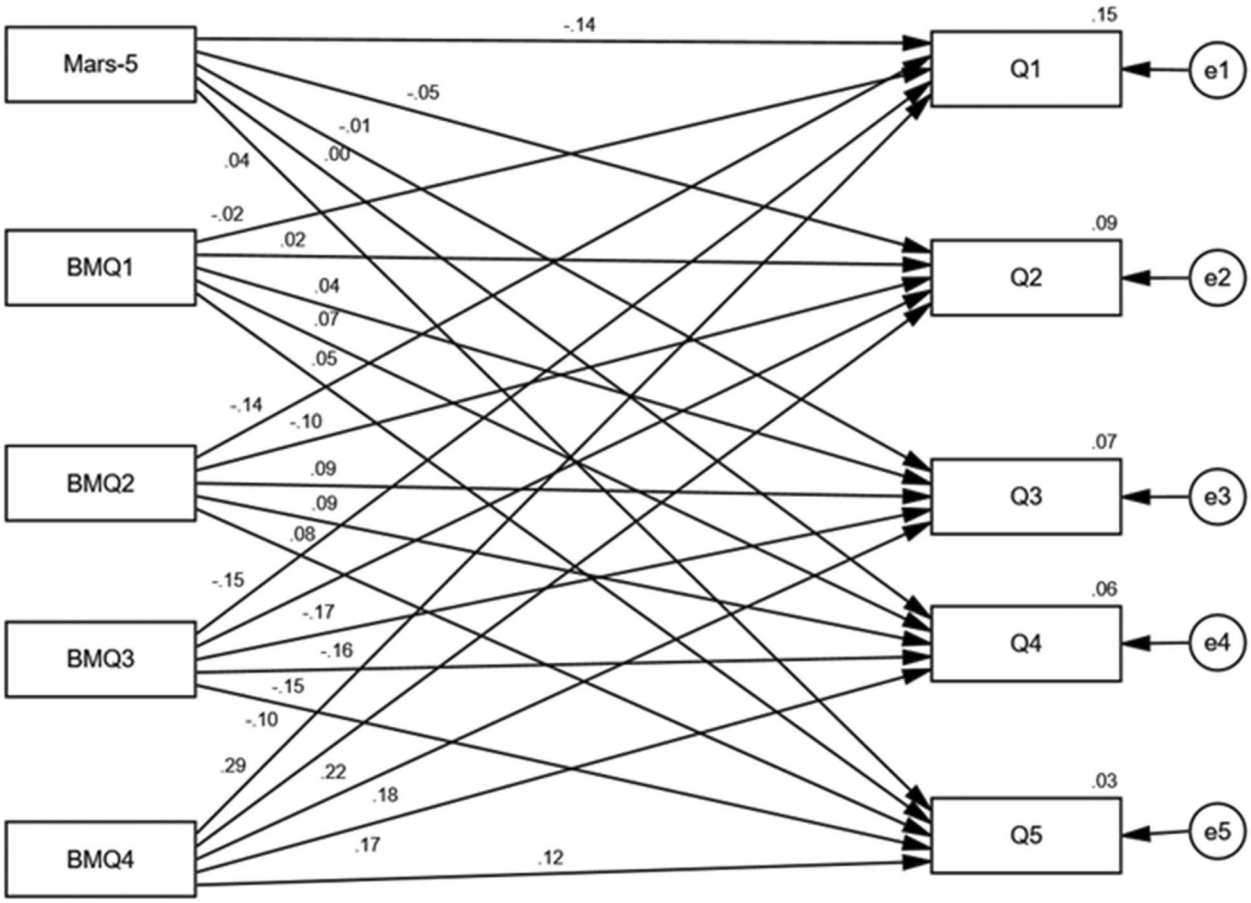

Fig. 3 Path analysis diagram and **s**tandard path coefficient; MARS: Medication Adherence Report Scale; BMQ: Beliefs about Medicines Questionnaire; Q: Quality; Q1: Pain; Q2: Physical function; Q3: Social function; Q4: General health perception; Q5: Mental function

that the disease may have a greater impact on their QoL may be more likely to adhere to drugs to prevent or reduce short- and long-term consequences. Health care providers should target and promote medication adherence to help improve the QoL of patients with OP. Future work should explore how altering these factors through intervention can improve health outcomes and QoL of patients with OP and any specific cutlural factors that can be enhanced through intervention.

Abbreviations

BMQ	Beliefs about Medicines Questionnaire
BMI	Body mass ındex
BMD	Bone mineral density
DXA	Dual energy X-ray absorptiometry
MARS	Medication Adherence Report Scale
SPSS	Statistical Package for Social Sciences
SD	Standard deviation
OP	Osteoporosis
Qualeffo	Quality of Life Questionnaire of the European Foundation for Osteoporosis
QoL	Quality of life
VAS	Visual analog scale

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Authors' contributions
TES, SA: data collection, writing, and supervision. TES: statistical analyses, supervision, critical analyses, and data collection. Both authors read and approved the final manuscript.

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Availability of data and materials
The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study protocol was approved by the Clinical Research Ethics Committee (Decision no: 2021/63; date: March 1, 2021). All procedures performed in studies involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its lateramendments or comparable ethical standards. Written informed consent was given from all participants.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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