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Health-related quality of life after rehabilitation from knee surgery in rural and urban settings: a quasi-experimental study

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Abstract

Background Injury to the knee joint is associated with physical disability, stiffness, pain, restriction of movement and impairment of the person's quality of life, with a few treatment options, including surgery and rehabilitation. This study aims to evaluate the impact of a rehabilitation program on the quality of life reported by patients living in rural and urban areas after knee surgery, using patient-reported outcome measures (PROMs).

Methods This quasi-experimental study with two groups of participants undergoing primary knee surgery was carried out in two rehabilitation centers, one in an urban area and another in a rural one. The same intervention was structured, with assessments at the start of the study (t0) and after a 4-week program (t1), and a comparison was made between the gains in rural and urban areas. We used descriptive and inferential analysis to analyze the effect of the intervention on health-related quality of life (HRQoL) using a linear regression model.

Results Participants ($n=62$ aged between 19 and 84 years (40% of the sample aged over 65years) and 61.9% female, showed improvements in their EQ-5D-5L and HADS scores after the rehabilitation program. Considering the dimensions of HRQoL in both groups, there was a significant improvement in all the components in the rural context ($p<0.005$), and improvements in the Mobility ($t=3.48$; $p=0.002$) and EQ_VAS ($t=-3.77$; $p=0.001$) components in the urban context. The effect of the program on health gains considering the Mobility was significantly greater in the rural group (−0.97) compared to the urban group (−0.13), as well as in the Pain/Disability (−0.73) vs. (−0.13) respectively. After analyzing the confounding factors, the rehabilitation center variable indicated gains of the EQ-5D-5L dimensions in a rural context ($\beta=-0.390$; $t=-3.041$; $p=0.004$), with an average reduction in health problems.

Conclusion There is evidence that the application of PROMs in rehabilitation programs after knee surgery is fundamental, considering the improvements in HRQoL and the optimization of anxiety/depression states in different contexts. PROMs should be applied systematically in clinical practice throughout the rehabilitation process, objectively measuring the results perceived by patients, and according to each context achieving health gains.

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Keywords Patient-reported outcome measures, Health-related quality of life, Rehabilitation, Knee surgery, Physical activity, Health status

Introduction

Musculoskeletal conditions affect people from all regions of the world and are one of the main causes of disability, being one of the top ten causes of disability-adjusted life years (DALYs) for men and women [1]. This is largely due to the ageing of the population and is currently considered a public health problem. In recent years, it has had a significant economic impact on health systems, not only because of the burdens associated with it, but also because of the costs it entails [2]. One of these conditions is associated with various types of injuries that compromise the knee joint, originating in the cartilage, menisci and ligaments [4], and which therefore compromise mobility, uncontrolled pain, osteoarticular stiffness, several physical limitations and reduced quality of life [5].

Treatment strategies for this health condition are designed according to the context of each patient, with the most common approaches being integrated into rehabilitation programs with or without surgical intervention. Both therapeutic options should be considered and integrated into a strategy that includes the various dimensions of the patient and the context in which they live, allowing for the restoration of mobility with improved joint function, symptom control with pain relief and optimization of quality of life [6]. When surgery is indicated, surgeons frequently utilize arthroscopy, osteotomy and arthroplasty procedures. The indication for knee arthroscopy is common, and it is estimated that more than 2 million procedures are performed worldwide each year [8]. Another surgical procedure is arthroplasty, indicated as a treatment when all other options have failed or are contraindicated. With an ageing population and an increasingly demanding level of activity, it is estimated that the number of knee replacement surgeries will continue to increase in the future [6].

After surgery, rehabilitation programs are fundamental to the recovery process. They make it possible to improve proprioception, strength and muscle function, which are compromised immediately after surgery by the reflex inhibition of motor neurons and the immobilization related to the post-operative period [4]. Assessing health-related quality of life (HRQoL) through patient-reported outcome measures (PROMs) will allow the rehabilitation process to be adapted to a given context, considering the results obtained directly from those who have experienced this process [12].

The evolution of PROMs has been significant in recent years, reflecting the updated focus on value-based and patient-centered healthcare [13]. The use of different scales makes it possible to assess the economic impact of care, as well as the state of health in the various dimensions (physical performance, mental performance and social performance) [14]. In the orthopedic field, and in this case, during the process of knee surgery, PROMs allow an evaluation beyond the surgical results and can measure outcomes that are relevant to patients, such as pain relief, restoration of function and improvement in quality of life [15]. Despite the benefits PROMs can provide, they are still not widely used in the rehabilitation process after knee surgery due to several factors, namely the difficulty in its implementation [17]. However, health professionals should focus with particular interest on the out-of-hospital rehabilitation of these patients, reinforcing health guidelines after discharge so that patients can maximize their HRQoL [15]. With this in mind, we used two generic PROMs, the EQ-5D-5L and the Hospital Anxiety and Depression Scale (HADS) not only to assess quality of life, anxiety and depression in this specific area of health, but also to contribute scientific evidence to support future clinical and political decisions [18]. Several experimental studies have shown through PROMs that rehabilitation programs after knee surgery have a positive cost-benefit ratio [19], that they reduce symptoms associated with anxiety and depression [20], and that they improve patients' HRQoL [16], but there is a gap in knowledge about the effectiveness of supervised rehabilitation programs on changes in HRQoL, considering the different contexts in which participants are placed. It is essential to consider this dimension, since contextual factors can influence the experience of patients undergoing knee surgery, through the availability of resources during the rehabilitation process, communication strategies between the health professional and patient, as well as the personal conditions of each person. Therefore, what are the health gains in rural and urban participants after a knee surgery rehabilitation program? The aim of this study was to assess the impact of a structured rehabilitation program on the quality of life reported by participants living in rural and urban areas after knee surgery using PROMs. As a secondary objective, we aimed to analyze the impact of patients' participation in a rehabilitation program after knee surgery on anxiety and depression.

Methods

Study design

This quasi-experimental study was carried out with participants who underwent knee surgery and took part in

the rehabilitation program at two rehabilitation centers located in an urban (Oeiras) and rural (Portel) region of Portugal, between September 2023 and March 2024. The location of the two centers implies different services for the community in each context, such as access to the central hospital with support for the orthopedics specialty at more than 30 km in rural areas, and for urban areas the quickest access at less than 30 km. This type of study made it possible to distribute participants non-randomly and to evaluate the program carried out in different territorial areas. The protocol was previously registered in the ClinicalTrial.gov registry {NCT06206018}, with the first registration 16/01/2024. This study was reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) statement [21], following the declaration of Helsinki. It was approved by the Ethics Committee of the National School of Public Health - NOVA University of Lisbon (CE-ENSP) with number 3/2022, and all participants agreed to take participate in the study by signing the informed consent form.

Participants

Participants undergoing knee surgery and proposed for a rehabilitation program at the two rehabilitation centers were admitted after a physiotherapy appointment, considering the inclusion criteria. The inclusion criteria were: (1) participants undergoing anterior cruciate ligament (ACL) surgery and total knee arthroplasty (TKA), with epidural anesthesia; (2) aged 18 or over; (3) able to complete the questionnaires; (4) consenting to take part in the study. Participants with permanent or temporary dysfunction of the central or peripheral nervous system, who had undergone previous surgery on the ipsilateral knee, with unconsolidated fractures and those with partial or total amputation of the upper or lower limbs were excluded. Online G*Power software (University of Dusseldorf, Dusseldorf, Germany) was used to calculate the sample size, determining a minimum of 60 patients (30 participants for each group) with an alpha error probability defined as 0.05, a sampling power of 0.5 (Power = 1-β err prob) and an effect size of 0.5 [22].

Procedure

After knee surgery, and after testing the exercise plan in a study carried out previously in one of the rehabilitation centers (Appendix), participants from two rehabilitation centers were proposed for the rehabilitation program. Eighty-six patients with an initial physiotherapy assessment were identified and invited to take part in the study.

After clarifying the objectives, the intervention and any other doubts, 62 people agreed to take part and were then accepted into two groups, 32 in the urban group and 30 in the rural group. In the first session, before starting any procedure, the participants answered sociodemographic questions and filled in the EQ-5D-5L and HADS questionnaires. At the end of the program, the participants filled in the questionnaires again, and all the data was coded and stored with password protection, considering the security recommended by the law in force (Portuguese Law nº. 58/2019 and European Regulation 2016/679).

Intervention

The intervention was carried out in both centers by the same two physiotherapists, based on the updated guidelines of the Journal of Orthopaedic and Sports Physical Therapy (JOSPT) for knee injuries [23]. The groups received the same program described in five weekly sessions for four weeks [24], including educational exercises, lower limb massage, mobilization, neuromuscular strengthening and rehabilitation, neuromuscular electrical stimulation of the quadriceps and cryotherapy at the end [4]. The patients were then treated with the following sequence: massage and knee mobilization, followed by an exercise program, neuromuscular electrical stimulation and cryotherapy.

The population that complied with the same program was monitored over time in both areas. This evaluation model works well, and once the effectiveness of the program has been tested, any difference observed between the two groups can be largely attributed to the context [25]. The different outcomes were assessed at the beginning before starting the intervention (t0), and at the last session (t1).

Patient-reported outcome measures

The results were obtained by applying and self-completing the PROMs at two points in time: at the start of the program (t0) and after the intervention protocol (t1). The internal consistency of the instruments used was assessed, as in the field of orthopedics, they must demonstrate adequate internal consistency due to the multiplicity of clinical phenomena [17]. The reliability of each questionnaire was then assessed using the Cronbach's alpha (α) internal reliability coefficient, as this is one of the best estimates for measuring the reliability of a test [27]. This Cronbach's α value allows us to estimate the average value of all the possible coefficients, to report the internal consistency of the instrument, and to demonstrate whether the researchers are measuring what they are supposed to be measuring, guaranteeing the effectiveness of the instrument's use in the study population [27]. The Cronbach's α value for all the items that made up the EQ-5D-5L was 0.776 (0.674–0.853 IC95%) in the initial application, demonstrating that the scale has a reasonable degree of homogeneity for assessing HRQoL. For the HADS scale, the Cronbach's α value was 0.881 (0.833–0.920 IC95%), which is considered to indicate

good homogeneity value. These PROMs were used to reliably assess HRQoL and anxiety/depression in participants in a rehabilitation program following knee surgery.

Health-related quality of life

The EQ-5D-5L, a valid and reliable measure, was used to assess HRQoL [29]. It was developed by the EuroQol group for use in economic evaluation in 1988, later revised to include only five dimensions, and in 2009 the group introduced the EQ-5D-5L which allows a descriptive system of five levels within the five dimensions [29]. It is an instrument in two parts, including a descriptive part made up of five Likert-type scale questions with response levels (from level 1 - no problems, to level 5 - with extreme problems) for the five health dimensions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) [18]. The second part of the instrument is a visual analog scale (EQ-VAS), scored by the participant by marking an 'x' on the numbered scale from 0 ('worst' HRQoL) to 100 ('best' HRQoL), indicating and measuring current general health [18]. This instrument, which aims to measure HRQoL and generate a value of the individual's state of health, already has a Portuguese version available.

Hospital anxiety and depression scale

The HADS was another of the generic PROMs used to assess the levels of anxiety and depression of participants in the rehabilitation program. This instrument was developed in 1983 to assess levels of anxiety and depression, and is therefore divided into two sub-scales, each consisting of seven items, scored from 0 to 3 points, with possible total scores ranging from 0 to 21 points (between 0 and 7 is 'normal', 8–10 is 'mild', 11–14 is 'moderate', 15–21 is 'severe') [31]. It is a dimensional questionnaire that has already been validated with participants in Portugal, and which allows us to assess patients' symptoms of anxiety and depression in different contexts (hospital, primary healthcare and community settings) [32]. These symptoms of anxiety and depression are often associated with medical illnesses and can negatively influence patient progression, as well as causing a high degree of personal, social and occupational dysfunction [32]. International research on HADS shows that it is a useful tool to evaluate anxiety and depression in people suffering from different diseases, and it is the only PROM that makes it possible to obtain anxiety and depression results that are not influenced by an individual's physical illness [32].

Statistical analyses

Different statistical procedures were used to analyze the data, including descriptive and inferential techniques. All study participants who could not be assessed on the EQ-5D-5L and HADS scales before and after the intervention were excluded from the data analysis. The central limit theorem was used to assess the distribution of the sample mean [25]. The results were expressed for both groups by the mean (±SD), and frequency distribution, using the Student's t-test was used for paired samples to calculate the differences between the groups at the different assessment times and considering different outcomes. To compare the values of the EQ-5D-5L scale dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression) and the HADS scale (anxiety, depression) before the intervention and 4 weeks after the intervention, the paired-sample t-test was used. To assess the quality-of-life gains measured by the EQ-5D-5L scale (mobility, self-care, usual activities, pain/discomfort, anxiety/depression), considering urban and rural regions, the independent-sample t-test was applied. We analyzed the relationships of all the variables in the causal diagram of the DAGitty platform (supplementary material), to minimize the possible biases of the confounding variables [34], and we used the multiple linear regression model with the Enter method, considering the sociodemographic variables and the gains in the dimensions of the EQ-5D-5L scale as independent variables. The variables sex, age, and participation in rehabilitation were transformed into dummy variables.

The effect size was reported, and a 95% confidence level was used for the statistical tests. Statistical Package for Social Sciences (SPSS®) 29 (IBM Corp, Armonk, Nova York, USA) software was used to analyze the data in this study.

Results

Patient characteristics

Among the participants (n=62) (Fig. 1), 61.9% were female and aged between 19 and 84. In the rural group, most participants (63.34%) were older than 60 years, with an average age of 63.37 (±13.94) years (Table 1). In the urban group, although the participants' ages ranged from 19 to 69 years, they were younger with an average of 43.16 (±13.83) years.

Changes in HRQoL and anxiety/depression

The evolution of the scores in all the dimensions of the EQ-5D-5L questionnaire showed a significant improvement in the HRQoL of the participants in the rural group over the course of the rehabilitation program (Table 2).

In the urban group, the t-test for paired samples was statistically significant only for the Mobility dimension (t=3.48; p=0.002), with an average difference of 0.47 between the two periods analyzed. In relation to the EQ_VAS score, there was also a substantial improvement in HRQoL in the urban setting (t=−3.77; p=0.001), with an average difference of −6.84 between the two periods analyzed.

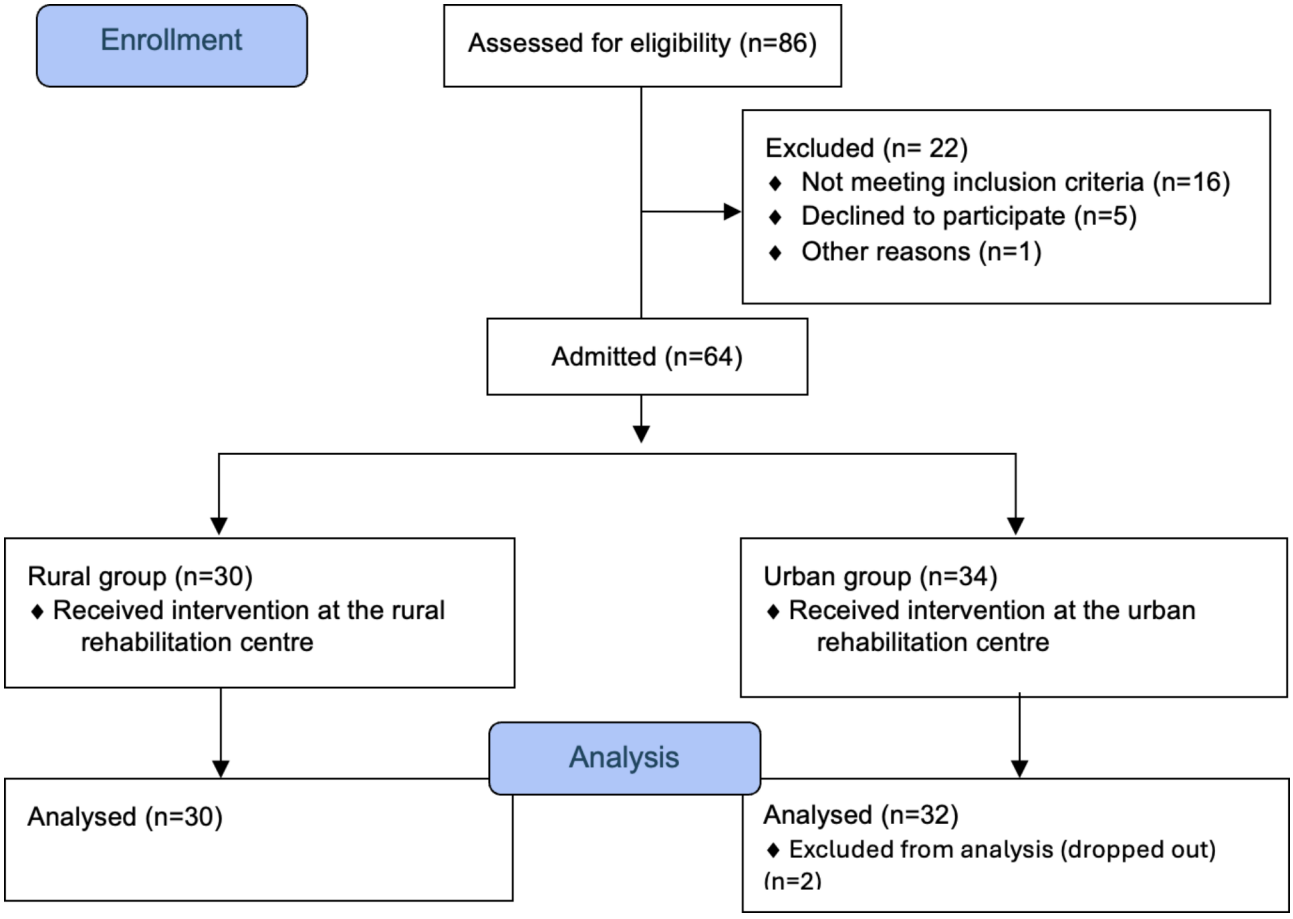

Fig. 1 Consolidated Standards of Reporting Trials (CONSORT) flow chart for trial recruitment (supplementary material)

Table 1 Sociodemographic characteristics of the participants (*n* = 62)

	Rural Group (*n* = 30)			Urban Group (*n* = 32)		
	Mean (± SD)	**Range**	**Frequency (*n*)**	**Mean (± SD)**	**Range**	**Frequency (*n*)**
Age (years)	63.37 (± 13.94)	19–84		43.16 (± 13.83)	19–69	
Age Group						
18–44			6.66% (2)			43.75% (14)
45–64			30% (9)			40.63% (13)
> 65			63.34% (19)			15.62% (5)
Sex						
Male			36.7% (11)			40.6% (13)
Female			63.3 (19)			59.4% (19)

SD = standard deviation

Regarding anxiety and depression, there were significant improvements in the HADS total score throughout the rehabilitation program in the rural group (p = 0.001), as well as in the urban group (t = 2.60; p = 0.01) with an average difference of 1.41 between the two periods analyzed. The Depression component score improved substantially in both groups, with an average difference of 0.75 between the two periods analyzed in an urban context (t = 2.36; p = 0.02). On the other hand, the Anxiety component score was positive in the groups in both contexts, however, it was only significantly observed in the group of participants in a rural context (p = 0.001).

Health gains

The t-test was applied for independent samples, and after analyzing the effect of the program comparing the difference between the final and initial value of the dimensions of the EQ-5D-5L scale, the mean values of the difference were obtained (Table 3).

Table 2 Characteristics of the scales used by the participants ($n=62$) in the rehabilitation program

	Baseline (t0)	4 weeks (t1)	*p*
	Mean (± SD)		
EQ-5D-5L			
Mobility			
Urban	2.00 (± 0.76)	1.53 (± 0.62)	0.002
Rural	2.53 (± 0.68)	1.57 (± 0.68)	0.001
Self-care			
Urban	1.25 (± 0.62)	1.03 (± 0.18)	0.07
Rural	1.67 (± 0.76)	1.30 (± 0.65)	0.003
Usual activities			
Urban	1.72 (± 0.99)	1.44 (± 0.67)	0.05
Rural	2.03 (± 0.67)	1.47 (± 0.73)	0.001
Pain/discomfort			
Urban	1.88 (± 0.71)	1.75 (± 0.76)	0.35
Rural	2.30 (± 0.54)	1.57 (± 0.63)	0.001
Anxiety/depression			
Urban	1.56 (± 0.67)	1.34 (± 0.55)	0.05
Rural	1.67 (± 0.80)	1.33 (± 0.61)	0.001
EQ_VAS			
Urban	77 (± 13.62)	83.84 (± 12.74)	0.001
Rural	74.93 (± 14.61)	85.87 (± 11.99)	0.001
HADS			
Anxiety			
Urban	4.88 (± 2.89)	4.21 (± 3.52)	0.07
Rural	5.63 (± 4.16)	4.27 (± 3.38)	0.001
Depression			
Urban	3.31 (± 2.24)	2.56 (± 2.55)	0.02
Rural	4.03 (± 3.2)	3.66 (± 2.98)	0.01
Total			
Urban	8.19 (± 4.62)	6.78 (± 5.51)	0.01
Rural	9.67 (± 7.31)	7.47 (± 5.69)	0.001

EQ-5D-5L = EuroQol 5 Dimensions instrument; HADS = Hospital Anxiety and Depression Scale; *P* = p-value; SD = standard deviation; VAS = Visual Analog Scale

Table 3 Evolution of HRQoL with health gains

	Urban Group		Rural Group		*p*
EQ-5D-5L	**Mean**	**SD**	**Mean**	**SD**	
Mobility	−0.47	0.76	−0.97	0.56	0.005**
Self-Care	−0.22	0.66	−0.37	0.61	0.37
Usual Activities	−0.28	0.81	−0.57	0.63	0.13
Pain/Discomfort	−0.13	0.75	−0.73	0.58	0.001***
Anxiety/Depression	−0.22	0.61	−0.33	0.48	0.41

p = p-value; ***$p \leq 0.001$; **$p \leq 0.01$; SD = standard deviation

In the mobility component, and taking into account the rural rehabilitation group, there were gains with very significant results t(60) = 2.92 (p = 0.005), in that the reduction in mobility problems was greater in this group compared to the urban (-0.97 vs. -0.47). In terms of pain and well-being, considering the same intervention in both groups, there were also showed significant differences t(60) = 3.54 (p = 0.001), with a greater reduction in pain in the rural group compared to the urban group (-0.73 vs. -0.13). In terms of health gains, these were higher in the rural group compared to the urban group, but the differences were not statistically significant (p = 0.06).

After using a linear regression model, the regression equation explained 22.8% of the health gains after the rehabilitation program. Therefore, sociodemographic aspects explained 3.6% (R^2 = 0.036) of the variance in the mean gains in the dimensions of the EQ-5D-5L, the context of the rehabilitation center 13.3% (R^2 = 0.133), and aspects related to anxiety and depression 5.9% (R^2 = 0.059) of the variance in the mean gains in the dimensions of the EQ-5D-5L (Table 4).

The model proved to be statistically significant (F = 3.299; p = 0.011), where it was found that at least one of the independent variables had a significant regression coefficient (Table 5).

In the regression model used, the values of β correspond to the rural group, where the urban group is taken as a reference. In Mod. 1, the variables sex and age did not have a significant impact on the average gains in the QoL dimensions (p = 0.639 and p = 0.194), so age and sex are not explanatory of the evolution of health gains in the participants in this study.

The integration of the rehabilitation center variable in Mod. 2 showed a statistically significant effect on the average index of gains in the HRQoL dimensions (β = −0.390, t = −3.041, p = 0.004) (Table 6).

Thus, when there is participation in a rehabilitation center in a rural context, there is a significant average reduction in health problems, which is reflected in health gains. By integrating the differences in anxiety and depression at the end of the program (Mod. 3), we can highlight health gains and at a clinical level due to the evolution in the anxiety dimension of the participants.

Table 4 Linear regression model between the variables under study and the gains in the EQ-5D-5L dimensions

Model	*R*	R^2	R^2 Ajusted	Standard Error			
					R^2	F	*p*
Sociodemographic aspects	0.190	0.036	0.004	0.423	0.036	1.109	0.337
Rehabilitation center	0.411	0.169	0.126	0.396	0.133	9.245	0.004*
Anxiety and Depression differences	0.477	0.228	0.159	0.389	0.059	2.131	0.128

***$p \leq 0.001$

Table 5 Analysis of the variance of linear regression between the variables under study and the average gains in the EQ-5D-5L dimensions

Model		Sum of squares	df	Mean squares	F	*p*
Mod. 1	Regression	0.397	2	0.199	1.109	0.337
	Residual	10.571	59	0.179		
	Total	10.968	61			
Mod. 2	Regression	1.851	3	0.617	3.925	0.013
	Residual	9.118	58	0.157		
	Total	10.968	61			
Mod. 3	Regression	2.496	5	0.499	3.299	0.011
	Residual	8.473	56	0.151		
	Total	10.968	61			

Table 6 Linear regression coefficients between variables under study and the average gains in the EQ-5D-5L dimensions

Model		Non-standardized coefficients		Standardized coefficients	t	*p*	95% IC	
		B	Standard error	Beta			Lower Limit	Upper Limit
Mod. 1	(Constant)	−0.395	0.081		−4.862		−0.558	−0.233
	Male	0.053	0.112	0.061	0.471	0.639	−0.171	0.277
	> 65 years	−0.155	0.118	−0.170	−1.313	0.194	−0.392	0.081
Mod. 2	(Constant)	−0.298	0.083		−3.607	< 0.001	−0.463	−0.133
	Male	0.079	0.105	0.092	0.751	0.456	−0.132	0.290
	> 65 years	0.110	0.141	0.121	0.782	0.438	−0.172	0.393
	Rehabilitation Center	−0.390	0.128	−0.464	−3.041	0.004	−0.647	−0.133
Mod. 3	(Constant)	−0.256	0.084		−3.055	0.003	−0.424	−0.088
	Male	0.069	0.106	0.079	0.648	0.520	−0.143	0.281
	> 65 years	0.092	0.139	0.101	0.665	0.509	−0.186	0.370
	Reabilitation Center	−0.342	0.128	−0.406	−2.664	0.010	−0.599	−0.085
	Anxiety_Differences	0.054	0.030	0.243	1.825	0.073	−0.005	0.113
	Depression_Differences	0.002	0.033	0.010	0.074	0.941	−0.063	0.068

Discussion

This clinical study made it possible to assess the quality of life reported by participants in a rehabilitation program after knee surgery, in both rural and urban contexts. The use of PROMs as an assessment measure during rehabilitation follow-up has allowed us to objectively understand the improvements in HRQoL anxiety/depression states. This assessment of HRQoL makes it possible to understand the effectiveness of rehabilitation programs, improve the rehabilitation process, adapt healthcare to the population and achieve considerable health gains [35].

Other authors reached the same conclusion using similar samples. In a randomized study in Sweden of 82 patients undergoing unilateral knee arthroplasty who took part in a 7-week rehabilitation program, the researchers analyzed the effect of strength training on knee range of motion, pain, disability and HRQoL [36]. Although the differences did not show a statistically significant result between the groups, the researchers observed an improvement in HRQoL and absence of pain at the end of the program [36]. In another randomized study with 83 patients, the authors evaluated the effect of a rehabilitation intervention on physical activity and HRQoL, testing its effectiveness after knee arthroplasty [37]. In participants with and without chronic pain, and using the EQ-5D-5L, the researchers observed significant improvements in physical activity and HRQoL from the start to 6 and 12 months [37].

The mobility component and the EQ_VAS score had a statistically significant positive evolution in both groups. In fact, after surgery, rehabilitation is recommended to reduce inflammation, increase knee range of motion, improve functionality and independence [38]. This concern with mobility and early encouragement to walk, considering the individual condition, makes it possible to promote the optimization of the quality of life of patients taking part in rehabilitation programs. In another study of 33 participants randomly allocated to a physiotherapy program after partial meniscectomy by arthroscopy, pain, quadriceps strength, knee range of motion, motor control and quality of life were analyzed [4]. After 2 and 4 weeks of intervention, there was a significant improvement in active range of motion at 45° and 90°, motor control and quality of life [4]. In fact, in rehabilitation processes there is a clear relationship between the mobility component and HRQoL, which is one of the most important dimensions of the EQ-5D-5L [17]. This PROM

is currently used in 61% of the main national and regional arthroplasty registries [35], suggesting the relevance of its use to assess the impact of mobility on HRQoL after knee surgery.

In addition to HRQoL, statistically significant results were also obtained in the HADS total score, representing improvements in anxiety and depression in both rehabilitation contexts. Anxiety and depressive symptoms are very common in patients with medical conditions and can lead to a reduction in quality of life and interfere with clinical progress. Çelebi et al. showed that the reduction in signs of anxiety and depression at the end of the rehabilitation program positively affected the emotional state of patients undergoing anterior cruciate ligament reconstruction [20]. In our study we also observed that the depression component improved substantially in both groups, and anxiety in the participants of the group in a rural setting. These results suggest that anxiety, being a psychophysiological reaction with probable negative consequences [20], may have its own characteristics on the state during the rehabilitation process. If we look at the initial assessment, we see that high anxiety scores at the start of the program in the group in a rural setting may suggest a reactive process to the injury associated with fear, but as knee function improves, there is a corresponding decline in anxiety scores [20]. In one of the studies carried out by Greenberg et al. in relation to rehabilitation programs after knee injury, they report that 45% programs that use patient-reported outcome measures, only 10% report fear [39]. Fear after knee injury may be due to high expectations of actual post-operative ability to participate in rehabilitation programs, or the fact that the ability to perform physical activity and exercise is lower than expected [41]. In fact, the factors that lead to feelings like fear after knee surgery in a rural context should be explored in future studies. The mental wellbeing can be just as important as physical fitness and activity restriction in determining self-reported quality of life outcomes after knee surgery [15]. This evidence on mental health as an indicator of the psychological state of patients with orthopedic pathology is fundamental, allowing the implementation of rehabilitation strategies and comprehensive models of care for the benefit of patients, populations and health systems [42].

Regarding the effect of this program in the two rehabilitation contexts, it was greater in the rural group compared to the urban group, having significantly reduced the mobility problem and pain/malaise. In fact, after analyzing the confounding factors, the health gains were higher in the rural group in elderly people aged > 65 years. These results may be related to several factors, namely the involvement of patients in the individual rehabilitation program, as well as the specific characteristics of the population of each group. Regarding patient involvement, this is considered one of the challenges in rehabilitation programs [39]. To improve patient involvement in the rehabilitation process, effective communication and personalized supervision by healthcare professionals are essential, adapted to the specific needs and daily schedules of patients, allowing greater flexibility in managing priorities [39]. This personalized planning of the entire rehabilitation program in a rural context, due to the greater availability of the patient, the health professional and the rehabilitation center, allows for greater efficiency in completing the proposed protocol and greater participant satisfaction [44]. In relation to the characteristics of the group in a rural context, with older participants, who live in a context of greater social isolation, lower economic capacity, and lower functional capacity, they have the possibility of participating in a personalized and multidisciplinary rehabilitation program focused on their individual recovery. This combination of factors combined with a structured program allows you to quickly recover functional mobility, improve independence compared to pre-surgical conditions, reduce fears associated with the already treated injury and motivate physical activity. In a recent study in the USA, a multicenter prospective cohort with 1,941 patients undergoing knee arthroplasty and a mean age of 64.5±8.9 years, Redfern et al. evaluated the expectations that patients had before and after surgery depending on the level of physical activity [45]. They concluded that patients in this age group, with low and moderate levels of physical activity, increased this activity after the treatment process [45]. In studies carried out on patients with orthopedic pathology in the same age group, when evaluating outcomes associated with treatment satisfaction in a rural context, a significant improvement was observed in the components of pain, functionality, expectations and HRQoL compared to participants in an urban context [46].

The use of personalized and structured programs in rehabilitation centers in rural contexts in the orthopedic area, in addition to improving patients' HRQoL and balance in access to specialized healthcare, allows for an efficient cost-benefit ratio in rural areas and optimization of strategies management in the health system.

Some limitations of this study should be recognized. The unintentional distribution by age can be considered a limitation of this study, although it has no statistical relevance as confirmed by the linear regression model. The sample size can also be considered a limitation, however it was analyzed and considered representative of the results obtained with G*Power software. Regarding the characteristics of the population, it was racially and ethnically homogeneous, limiting the generalization of the results to areas where there is greater cultural diversity. Although the patients underwent surgery in surgical centers with the same level of evolution as the guidelines

for this type of surgery, it was not possible to analyze the results considering the surgical technique of each surgeon and the specific technological evolution in each surgical center. The last limitation is related to the treatment conditions of each rural rehabilitation center in different countries around the world. Therefore, it is important to consider the socioeconomic context of other countries with different levels of economic development in the health sector.

Conclusions

We contribute by providing recommendations regarding the application of PROMs used in rehabilitation programs after knee surgery, considering HRQoL and the optimization of anxiety and depression states in different socioeconomic contexts. Measuring the results reported by patients is fundamental in the current health context, allowing through a rehabilitation program to optimize physical condition, increase adherence to physical activity and exercise, improve motivation, reduce fears associated with treatment and improve HRQoL. The assessment of the HRQoL of patients, and in this case of participants in a rehabilitation program has taken over significant importance in the evolution of care provided, promoting positive changes in health status and the quality of services provided.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12891-024-08143-0.

Supplementary Material 1

Supplementary Material 2

Author contributions

JM and PB participated in the conception and design of the study. JF and MM was responsible for the acquisition of data. JM, AJ, PA and PB analyzed and interpreted the data. JM drafted the manuscript and AR and MA critically re-vised the manuscript for important intellectual content. All authors confirmed the final version of manuscript.

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Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval

This study was conducted in accordance with the Declaration of Helsinki. Approval was granted by the Ethics Committee of the Nacional School of Public Health – NOVA University of Lisbon (CEENSP n°3/2022).

Consent to participate

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

Competing interests

The authors declare no competing interests.

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