

Impact of Physical Rehabilitation on Sexual Function of Patients after Liver Transplantation in a Teaching Hospital

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ABSTRACT

Objectives: There is a lack of data regarding the effects of exercise on sexual function after liver transplantation (LT). This research, conducted in the Northeast of Brazil, aimed to assess the impact of an 8-week rehabilitation program on the sexual function of patients following LT, compared to a control group (CG) not participating in an exercise program. **Methods:** This controlled, nonrandomized pilot study enrolled patients in an 8-week, thrice-weekly, comprehensive, supervised rehabilitation program initiated 1 month after LT. A nonrandomized CG of patients was selected to match the physical rehabilitation group (PRG) based on specific demographic data and disease severity. **Results:** Both groups were comparable in baseline measurements; before the intervention, the mean sexual scores for PRG vs. CG were 62.9 (95%CI 56.8–68.8) and 54.8 (95%CI 48.7–61.0), respectively, and the difference was not statistically significant. After the intervention, the mean sexual scores for PRG vs. CG increased to 82.8 (95%CI 78.9–86.8) and 70.5 (95%CI 66.1–74.9), respectively, and were statistically significant. The effect of PR over the 8 weeks significantly impacted sexual function, with higher sexual scores in week 8 following rehabilitation compared to week 1 (83.2 ± 5.8 and 95%CI [71.6–94.6] vs. 62.4 ± 4.1 and 95%CI [54.6–70.3]; $p < 0.001$) for both genders. **Conclusion:** This work contributes to filling a gap in studies exploring the positive effects of physical exercise on sexual function among patients after LT. This provides a framework for implementing timely interventions related to specific behaviors.

Descriptors: Liver Transplantation; Physical Rehabilitation; Sexuality.

Impacto da Reabilitação Física na Função Sexual de Pacientes após Transplante Hepático em um Hospital Universitário

RESUMO

Objetivos: Há uma carência de dados sobre os efeitos do exercício físico na função sexual após o transplante hepático (TH). Esta pesquisa, realizada no nordeste do Brasil, teve como objetivo avaliar o impacto de um programa de reabilitação de 8 semanas na função sexual de pacientes após o TH, em comparação a um grupo controle (GC) que não participou de um programa de exercícios. **Métodos:** Este estudo piloto controlado e não randomizado incluiu pacientes em um programa de reabilitação abrangente e supervisionado de 8 semanas, com três sessões semanais, iniciado 1 mês após o TH. Um GC não randomizado de pacientes foi selecionado para ser pareado ao grupo de reabilitação física (GRF) com base em dados demográficos específicos e gravidade da doença. **Resultados:** Ambos os grupos foram comparáveis nas medidas basais; antes da intervenção, as médias dos escores sexuais para o GRF vs. GC foram 62,9 (IC95% 56,8–68,8) e 54,8 (IC95% 48,7–61,0), respectivamente, e a diferença não foi estatisticamente significativa. Após a intervenção, as pontuações médias de função sexual para GRF vs. GC aumentaram para 82,8 (IC95% 78,9–86,8) e 70,5 (IC95% 66,1–74,9), respectivamente, e foram estatisticamente significativas. O efeito da reabilitação física ao longo das 8 semanas impactou significativamente a função sexual, com pontuações mais altas na 8ª semana após a reabilitação em comparação com a 1ª semana [$83,2 \pm 5,8$ e IC95% (71,6–94,6); vs. $62,4 \pm 4,1$ e IC95% (54,6–70,3); $p < 0,001$] para ambos os sexos. **Conclusão:** Este trabalho contribui para preencher uma lacuna nos estudos que exploram os efeitos positivos do exercício físico na função sexual em pacientes após TH. Isso fornece uma estrutura para a implementação de intervenções oportunas relacionadas a comportamentos específicos.

Descritores: Transplante Hepático; Reabilitação Física; Sexualidade.

INTRODUCTION

Orthotopic liver transplantation (OLT) is currently the primary treatment for patients with end-stage liver disease (ESLD) and acute liver failure. The public health system performs over 95% of LT in Brazil.¹

Patients with ESLD experience a high rate of sexual dysfunction, with rates reaching as high as 79% in men and 64% in women. As disease severity increases, liver dysfunction and portal hypertension lead to altered metabolism and trafficking of sex hormones, which further impact sexual function. In addition, many comorbid conditions, such as anxiety, depression, and chronic pain, can contribute to poor sexual function.^{2,3}

Hormone imbalances caused by cirrhosis can, in theory, be corrected after LT. Furthermore, OLT enhances psychological well-being and improves overall quality of life, positively influencing various aspects of sexual health. However, the literature on sexual health following OLT is mixed, with conflicting results. A previous study showed that patients with liver cirrhosis had an equal prevalence of sexual function before and after transplantation, with a correlation to depression and reduced quality of life in the post-transplant phase.⁴ A meta-analysis showed that patients reported statistically significant improvements in sexual function after LT.⁵ Another study reported satisfactory sexual health after LT (75% had weekly intercourse associated with orgasm in 70% of cases).⁶

Using disease-specific questionnaires is a reasonable first step for screening sexual dysfunction. The Male Sexual Quotient (MSQ) and Female Sexual Quotient (FSQ) questionnaires are easy to administer and reproduce, and they can assess the full range of male and female sexual function.^{7,8}

The literature shows that physical rehabilitation (PR) following LT improves functional status, health-related quality of life, and fatigue.⁹

However, there is a lack of specific studies on the effect of PR on sexual function after LT. Improving the sexuality of these patients is an important step toward achieving complete physical and psychological rehabilitation after LT.⁵

We hypothesized that early PR benefits LT recipients by enhancing their fitness and sexuality 1 month after LT, compared to a matched group of patients not participating in an exercise program.

The objective of this study was to evaluate the effect of an 8-week PR program on sexual function and satisfaction after LT, compared to a matched group of patients not participating in an exercise program.

METHODS

Design

A controlled, nonrandomized pilot trial was conducted at a teaching hospital in Fortaleza, Northeastern Brazil. The PR group (PRG) consisted of patients who participated in supervised PR 1 month after LT. This group was monitored by physicians and physical therapists. The CG consisted of LT patients who received guidance on home exercises but did not participate in a rehabilitation program.

Enrollment

We used a convenience sample of patients who met the following eligibility criteria: those older than 18 years who had completed 1 month after LT. The specific exclusion criterion was contraindication to exercise training (cardiac disease, orthopedic limb, motor problems). Patients from both groups were selected simultaneously and matched by age, sex, and body mass index (BMI). Proximity to the hospital was taken into consideration when allocating patients to the PRG. They were required to attend the hospital three times per week for 8 weeks. All participants received study information and signed a consent form. The study was previously approved by the institution's research ethics committee under number 2079277 and registered in the Brazilian Clinical Trials Registry under number RBR-5jrtxb.

Patient assessments

At baseline, age, sex, and BMI were recorded. Sexual function scores were measured before and after the intervention.

The primary outcome was sexual function, assessed using the MSQ and FSQ questionnaires, each comprising 10 items and scoring from 0 to 100. The higher the scores, the better. The questionnaires were administered face-to-face. We provided a secure, private environment to gather more precise and comprehensive data.

The MSQ includes questions on desire, self-confidence, foreplay, erection, ejaculation, orgasm, and overall satisfaction. The FSQ assesses desire, arousal, foreplay, comfort during intercourse, orgasm, and sexual satisfaction.^{7,8}

PR program

The PR program consists of three physical exercise sessions per week, breathing techniques, and educational sessions. Patients in the PRG group performed warm-up exercises, including stretching for cervical muscles, the shoulder girdle, and the upper and lower limbs, before the rehabilitation sessions. Each stretching position was held for 30 seconds, for a total of 5 minutes. Aerobic conditioning for the lower limbs was performed by walking for 40 minutes at a pace matching that achieved during evaluation tests, with daily progression in time and speed. Strengthening of upper and lower limbs was initially performed with 50% of the maximum load achieved in the one-repetition maximum test, in two sets of six repetitions, with daily progression of repetitions and weekly load progression (10% per week). During the sessions, peripheral oxygen saturation, heart rate, perceived dyspnea on the Borg scale, and blood pressure were monitored, along with monitoring of clinical manifestations such as dizziness, nausea, headache, and muscle pain. All examinations and tests were conducted over 2 days, alternating functional capacity tests with tests that did not require physical effort. Each examination was performed at approximately 1-hour intervals to avoid patient fatigue and was conducted by the same evaluator.

Patients in the CG group were informed about the importance of incorporating physical activity into their routine and encouraged to walk at home. They were advised to start walking for 10 minutes/day and increase it by 5 minutes each day until reaching 30 minutes/day. Caregivers (relatives, friends) were invited to listen to the information. All patients in both study groups participated in educational sessions on the importance of physical activity and received guidance on a structured diet to maintain good nutrition.

Power analysis and statistical methods

A post hoc sample size calculation was performed using G*Power, with a sample size of 54 observations. After the intervention, the mean sexual scores for PRG were 82.7 ± 9.7 , and for the CG, 70.5 ± 10.1 . The effect size was 0.79, with a significance level of 5%. Using a *t*-test, our study achieved 80% power.

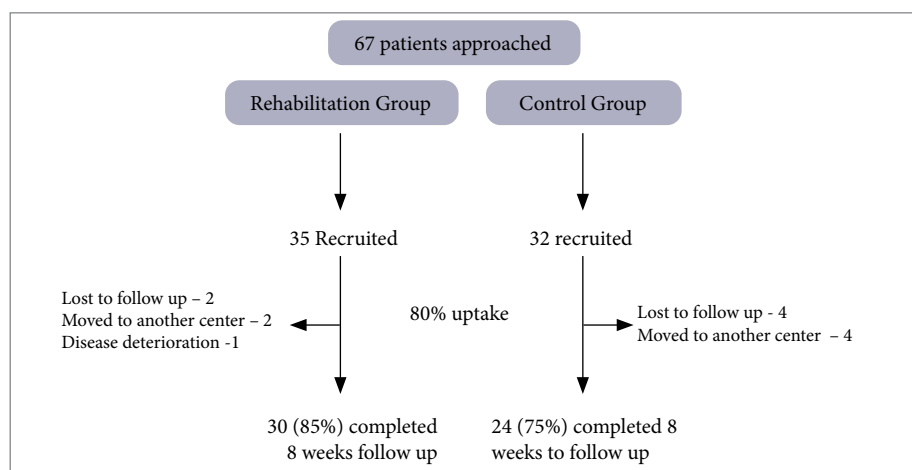
Descriptive statistics (means, standard deviations) were calculated for all continuous variables (age, BMI, and sexual scores), and frequencies were generated for categorical variables (two groups: PRG vs. CG). The mean values of the two groups were compared using Student's *t*-test. Pearson's chi-square test was used to assess the association between two categorical variables. We used generalized estimating equations (GEE) to assess the effects of rehabilitation interventions (PRG vs. CG), time (before and after), and their interaction on sexual function scores. Effect sizes were estimated using standardized beta coefficients (β). GEE is a repeated-measures analysis and has key advantages over standard analysis of variance (ANOVA), especially in small-sample designs, where ANOVA assumptions are rarely met. Benefits include the ability to use different distributions for the dependent variable parameters.¹⁰ All statistical analyses were performed with the IBM SPSS Statistics software package, version 21.0 (IBM Corporation, Armonk, NY, USA).

RESULTS

Thirty patients in the treatment group completed the 2-month PR program, and 24 patients in the CG completed the 2-month follow-up, engaging in physical activity and diet at home according to the teaching program guidelines (Fig. 1). The baseline characteristics of both groups were similar. One month after the intervention period, the sexual function scores of the PRG group (82.7 ± 9.7) were significantly higher ($p < 0.05$) than those of the CG group (70.7 ± 10.1) (Table 1).

The data were analyzed using a GEE with a gamma distribution and identity link function. This model yielded better fit statistics under the quasi-likelihood under the independence model criterion (QIC = 14.65) than a standard normal GEE with the identity link function (QIC = 17.40). The QIC is interpreted with smaller values being preferable,⁶ suggesting that, for this repeated-measures design, the gamma GEE is the most suitable for our data.

The GEE analysis, adjusted for the covariate gender, revealed a significant effect of the intervention (Wald [1, 52] = 9.82; $p = 0.002$), time (Wald [1, 52] = 310; $p = 0.001$), and the interaction between time and intervention (Wald [1, 52] = 5.34; $p = 0.03$) on sexual function. However, the covariate gender did not influence sexual scores (Wald [1, 52] = 1.77; $p = 0.18$); both males and females improved after 8 weeks of intervention. As shown in Fig. 2b, before the intervention, the means of MSQ and FSQ were 60.5 (95%CI 55.6-65.5) and 55 (95%CI 46.3-63.8), respectively, with a mean difference of 5.51 (95%CI -4.51-5.5). After the intervention, the means of the MSQ and FSQ increased to 77.9 (95%CI 74.1-81.6) and 75.3 (95%CI 68.6-82), respectively, with a mean difference of 3.83 (95%CI -5.17-10.2), but the difference was not statistically significant.



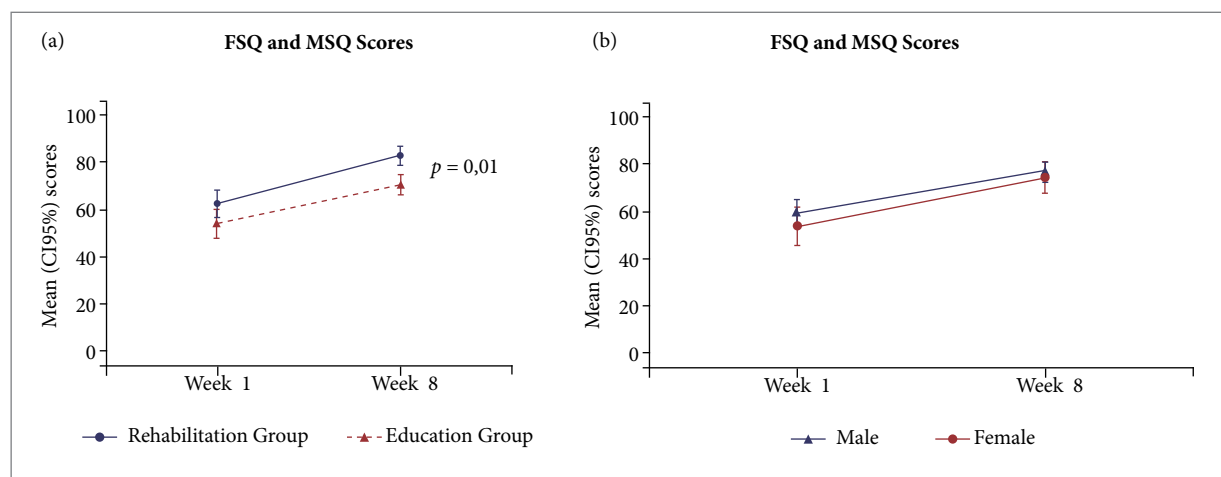
Source: Elaborated by the authors.

Figure 1. Study flow diagram.

Table 1. Baseline and 1 month after the intervention: characteristics of the 54 participants according to the groups.

	Baseline characteristics			1 month after intervention		
	Rehabilitation group (30)	Educational group (24)	<i>p</i> -value	Rehabilitation group (30)	Educational group (24)	<i>p</i> -value
Gender male (n [%])	22 (62%)	19 (59%)	0.61			
Age, years (mean $\pm$ SD)	53.3 $\pm$ 12.7	54.1 $\pm$ 9.4	0.50			
BMI (kg/m ²) (mean $\pm$ SD)	25.0 $\pm$ 3.1	25.5 $\pm$ 3.4	0.99			
Sexual satisfaction scores (mean $\pm$ SD)	62.9 $\pm$ 15.9	54.8 $\pm$ 14.8	0.06	82.7 $\pm$ 9.7	70.5 $\pm$ 10.1	0.001

Source: Elaborated by the authors.



Source: Elaborated by the authors.

Figure 2. a) Effect of interventions on sexual scores among participants after LT. b) The effect of gender on sexual scores among participants after LT. 95%CI error bars that do not overlap represent significant differences at a 0.05 level.

Regarding the intervention, both groups (PRG and CG) showed improvement, but the effect was more pronounced in PRG. Over 8 weeks, the PRG exhibited a significant increase in sexual behavior, with higher scores at week 8 than at week 1 (83.2 $\pm$ 5.8 vs. 62.4 $\pm$ 4; *p* < 0.001; β = 4.29). Before the intervention, the mean sexual scores for PRG vs. CG were 62.9 (95%CI 56.8-68.8) and 54.8 (95%CI 48.7-61.0), respectively, with a mean difference of 7.97 (95%CI -0.46-16.4), which was not statistically significant. After the intervention, the mean sexual scores for PRG vs. CG increased to 82.8 (95%CI 78.9-86.8) and 70.5 (95%CI 66.1-74.9), respectively, with a mean difference of 12.2 (95%CI 6.53-17.9), which was statistically significant (Fig. 2a).

DISCUSSION

This study demonstrated that an 8-week PR program after LT positively impacts sexual function and satisfaction. This finding highlights the importance of implementing PR programs for patients after LT.

Despite partial recovery, sexual function remains low after LT.^{4,11-13} In our study, sexual function scores post-transplant and before interventions were low for patients in the PRG (62 out of 100) and CG (54 out of 100). Several studies have identified possible contributors to these low sexual scores after LT, including aging, immunosuppression, cardiovascular disease, post-transplant diabetes, alcohol abuse, antidepressants, and angiotensin II receptor blockers.^{5,11,14}

After the intervention, the PRG improved by 12.2 points. Physical exercise can explain this enhancement in sexual function and satisfaction by impacting physiological and social factors. Exercise also increases blood flow, which is essential for arousal and erections, and increases energy levels and overall quality of life. Additionally, it can positively influence hormone levels, leading to a better sexual experience. Physical activity releases endorphins that reduce stress and anxiety, which positively affect sexual desire and performance.¹⁵

We observed that both males and females improved after 8 weeks of post-LT intervention. Obuekwe et al.¹⁶ conducted a retrospective cohort study and observed a significant improvement in sexual function for both men and women after a solid organ transplant.

This study has several strengths, such as it assessed sexual function separately in men and women after LT, using a well-designed and validated questionnaire. They were conducted as face-to-face interviews. This is useful, since participants may be more comfortable discussing the sensitive, detailed topics of sexuality in a one-on-one setting. Previous studies have shown that data obtained using interviewer-assisted methods are of good quality.^{16,17} Another strength of our study is that we used a GEE analysis. This analysis offers an alternative to repeated-measures ANOVA and repeated-measures multivariate analysis of variance (MANOVA) in research, including the ability to use different distributions for the dependent variable's parameters, which is a better approach for data collected at different time points, and provides improved adjustment for small sample sizes.¹⁰

A limitation of this study was the nonrandom allocation of participants. This can cause selection bias; to reduce it, patients from both groups were selected simultaneously and matched on age, sex, and BMI. Additionally, to reduce the risk of dropout, we allocated patients to the intervention group based on their distance from the hospital. Given the small sample size, this research suffers from limited generalizability. However, a post hoc sample size calculation showed sufficient power for the results.

Furthermore, we have to consider that before this work, we knew very little about the effect of physical exercise on sexuality after LT. We provide evidence from a single-center study that a PR program delivered by a team of trained professionals at a referral center contributed to improving sexual satisfaction in both men and women.

This initial pilot study offers foundations for further research: i) studies are necessary to determine the best exercise and optimal duration of the PR program; ii) a multicenter randomized controlled trial to assess the impact of PR on sexual health in LT patients, including different age groups, comprehensive hormonal profiling, and interventions with sexual counseling provided by trained professionals.

CONCLUSION

This study suggests that individual attention should be given to the sexual function of these patients and that new strategies, such as PR, are essential to support them and implement timely interventions.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Pereira E, Bentes C, Holanda MA. **Conception and design:** Bentes C, Tomaz BS. **Data analysis and interpretation:** Holanda MA, Mont'Alverne DGB, Cavalcante AGM. **Article writing:** Bentes C, Pereira E, Daher EF. **Critical revision:** Garcia JHP, Cavalcante AGM. **Final approval:** Pereira E, Bentes C.

DATA AVAILABILITY STATEMENT

The data will be made available upon request.

FUNDING

Not applicable.

DECLARATION OF USE OF ARTIFICIAL INTELLIGENCE TOOLS

No artificial intelligence tools were used.

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Not applicable.

REFERENCES

1. Nascimento SML, Fabris MEM, Barros JM, Ribeiro LM, Frizanco AB, Santiago ALP, et al. Liver Transplantation in Brazil between 2010 and 2021: 30-day survival. *Braz J Transplant*, 2023; 26(1). https://doi.org/10.53855/bjt.v26i1.541_ENG
2. Lee JY, Shin DW, Oh JW, Kim W, Joo SK, Jeon MJ, et al. Non-alcoholic fatty liver disease as a risk factor for female sexual dysfunction in premenopausal women. *PLoS One*, 2017; 12(8): e0182708. <https://doi.org/10.1371/journal.pone.0182708>
3. Yoo HJ, Lee B, Jung EA, Kim SG, Kim YS, Yoo JJ. Prevalence and risk factors of erectile dysfunction in patients with liver cirrhosis: a systematic review and meta-analysis. *Hepatol Int*, 2023; 17(2): 452-62. <https://doi.org/10.1007/s12072-021-10270-y>
4. Ferrarese A, Hurtado Díaz de León I, Tapper EB, Burra P. Sexual health and function in liver disease. *Hepatol Commun*, 2025; 9(4): e0691. <https://doi.org/10.1097/HC9.0000000000000691>
5. Burra P, Germani G, Masier A, De Martin E, Gambato M, Salonia A, et al. Sexual dysfunction in chronic liver disease: is liver transplantation an effective cure? *Transplantation*, 2010; 89(12): 1425-9. <https://doi.org/10.1097/TP.0b013e3181e1f1f6>
6. Parolin MB, Coelho JC, Urbanetz AA, Pampuch M. Contracepção e gravidez após transplante hepático – uma visão atual. *Arq Gastroenterol*, 2009; 46(2): 154-8. <https://doi.org/10.1590/S0004-28032009000200015>
7. Abdo CH. The male sexual quotient: a brief, self-administered questionnaire to assess male sexual satisfaction. *J Sex Med*, 2007; 4(2): 382-9. <https://doi.org/10.1111/j.1743-6109.2006.00414.x>
8. Abdo CHN. Development and validation of female sexual quotient - a questionnaire to assess female. *Rev Bras Med* 2006 [cited 2006 Sept]; 63(9). Available at: <https://pesquisa.bvsalud.org/portal/resource/pt/biblio-945578>
9. Moya-Nájera D, Moya-Herraz Á, Compte-Torrero L, Hervás D, Borreani S, Calatayud J, et al. Combined resistance and endurance training at a moderate-to-high intensity improves physical condition and quality of life in liver transplant patients. *Liver Transpl*, 2017; 23(10): 1273-81. <https://doi.org/10.1002/lt.24827>
10. de Melo MB, Daldegan-Bueno D, Menezes Oliveira MG, de Souza AL. Beyond ANOVA and MANOVA for repeated measures: advantages of generalized estimated equations and generalized linear mixed models and its use in neuroscience research. *Eur J Neurosci*, 2022; 56(12): 6089-98. <https://doi.org/10.1111/ejn.15858>
11. Coelho JCU, Freitas ACD, Matias JEF, Pissaiá Jr. A, Godoy JL. Sexual dysfunction in males with end-stage liver disease: partial recovery after liver transplantation. *J Liver Dis Transplant*, 2014;3:2 <https://doi.org/10.4172/2325-9612.1000122>
12. Park ES, Villanueva CA, Viers BR, Siref AB, Feloney MP. Assessment of sexual dysfunction and sexually related personal distress in patients who have undergone orthotopic liver transplantation for end-stage liver disease. *J Sex Med*, 2011; 8(8): 2292-8. <https://doi.org/10.1111/j.1743-6109.2011.02264.x>
13. Klein J, Tran SN, Mentha-Dugerdil A, Giostra E, Majno P, Morard I, et al. Assessment of sexual function and conjugal satisfaction prior to and after liver transplantation. *Ann Transplant*, 2013; 18: 136-45. <https://doi.org/10.12659/AOT.883860>
14. Karabulut, N., Koraş, K., & Gürçayır, D. Effects of liver transplantation on sexual function and quality of life. *Psychol Health Med*, 2021; 27(7): 1532-43. <https://doi.org/10.1080/13548506.2021.1898003>
15. Almuqahwi A, Alabdralridha H, Aljumaiah RM, Alfaifi AJ, Alnaim ME, Alfaifi IA, et al. A systematic review on the relationship between physical activity and sexual function in adults. *Cureus*, 2023; 15(12): e51307. <https://doi.org/10.7759/cureus.51307>

16. Obuekwe O, Clark H, Saffati G, Yatsenko T, Oscar-Thompson L, Riveros C, et al. The impact of solid organ transplantation on sexual dysfunction and infertility in older men and women: a claims based study. *Int J Impot Res*, 2025. <https://doi.org/10.1038/s41443-025-01127-1>
17. Norman R, King MT, Clarke D, Viney R, Cronin P, Street D. Does mode of administration matter? Comparison of online and face-to-face administration of a time trade-off task. *Qual Life Res*, 2010; 19(4): 499-508. <https://doi.org/10.1007/s11136-010-9609-5>