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ORIGINAL RESEARCH

Health-Promoting Lifestyle and Its Predictors in Renal Transplant Recipients in Hunan, China: A Cross-Sectional Study

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Background: Kidney transplantation is a critical treatment for end-stage renal disease (ESRD), with health-promoting lifestyle (HPL) significantly impacting patient outcomes. HPL involves behaviors like regular exercise, balanced nutrition, stress management, and habit modification. However, few studies have analyzed the HPL of renal transplant recipients, addressing a significant gap in current research.

Objective: This study aimed to determine the predictors of HPL in renal transplant recipients using the Chinese Health Promoting Lifestyle Profile (HPLP).

Methods: This cross-sectional study enrolled renal transplant recipients completing the revised Chinese HPLP at organ transplant center in a tertiary hospital in Hunan Province of China between May 2022 and July 2022.

Results: A total of 450 patients were included, comprising 256 males (56.9%), with a mean age of 44.85 ± 10.57 years. The mean score of self-actualization, health responsibility, interpersonal support, physical activity, stress management, nutrition, and overall HPLP were 15.27 ± 5.03 (possible range: 0–24), 11.41 ± 4.18 (possible range: 0–24), 11.61 ± 3.13 (possible range: 0–18), 7.53 ± 3.79 (possible range: 0–18), 12.68 ± 3.61 (possible range: 0–21), 11.17 ± 2.41 (possible range: 0–15), and 69.66 ± 16.98 (possible range: 0–120), respectively. Multivariate logistic regression analysis showed that urban residence (OR = 2.061, 95% CI: 1.350–3.148, P = 0.001), non-smoking after transplantation (OR = 2.010, 95% CI: 1.123–3.600, P = 0.019) and two post-transplant complications (OR=0.387, 95% CI: 0.218–0.689, P = 0.001).

Conclusion: Although renal transplant recipients exhibit a moderate level of HPL, targeted interventions are essential to improve these behaviors. These interventions should focus especially on individuals from rural households, post-transplant smokers, and those experiencing post-transplant complications, to enhance their quality of life and clinical outcomes.

Keywords: health promotion, healthy lifestyle, kidney transplantation, cross-sectional study

Introduction

Kidney transplantation, the most established and extensive transplant program globally, offers patients with end-stage renal disease (ESRD) a superior alternative to dialysis by significantly reducing mortality and enhancing quality of life.[1,2] As transplant technology advances, an increasing number of patients opt for this procedure. The World Health Organization's Global Observatory on Donation and Transplantation reported 100,097 kidney transplants worldwide in 2019.[3] However, recipients encounter numerous post-transplant complications and must maintain lifelong immunosuppressive therapy, which, despite an excellent initial graft survival rate of 96–98%, often leads to unsatisfactory long-term outcomes with a diminished 10-year graft survival rate.[4] Research indicates that lifestyle factors are modifiable health-risk factors that can negatively impact the prognosis of renal transplant recipients.[5,6] Adhering to a healthy lifestyle, including a balanced diet, regular physical activity, and consistent healthcare, may decrease the risk of acute rejection,

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graft loss, and mortality post-transplantation. Thus, promoting a healthy lifestyle is crucial for the long-term well-being of both renal transplant recipients and the viability of their transplanted kidneys.

The World Health Organization (WHO) defines lifestyle as personal behaviors aimed at disease prevention and mortality reduction.[7] Professor Pender's Health-Promoting Lifestyle (HPL) concept involves self-initiated actions for well-being, including a healthy diet, regular exercise, tobacco avoidance, adequate sleep, and stress management.[8,9] Unhealthy lifestyles can raise disease rates, lower productivity, and increase healthcare costs, impacting society economically.[10] HPL have gained global public health attention, with research indicating variability in HPL adoption across different demographics, including age, sex, education, income, and BMI, as well as cultural factors.[11–15] In addition, HPL is linked to health literacy, quality of life, and family dynamics.[16,17] Non-adherence to immunosuppressants after transplantation is prevalent, with estimates suggesting over a third of recipients may be non-compliant.[18] A rise in sedentary behavior and anxiety is observed one year post-transplant.[19] While some renal transplant recipients may struggle with dietary adherence and self-management, it's not universal. Post-transplant quality of life necessitates ongoing self-care and compliance; thus, promoting health-related behaviors is vital to enhance recipients' adherence to HPL.[7,20,21]

HPL is pivotal to the clinical outcomes of renal transplant recipients, and identifying its risk factors can enable healthcare providers to target education efforts, potentially enhancing recipients' survival and quality of life. Despite some understanding of HPL risk factors in the general population, there is considerable variability in research outcomes, and the mechanisms influencing HPL in renal transplant recipients are not fully understood. This study aims to investigate HPL predictors specifically within the renal transplant population using the Chinese HPLP, with the goal of developing strategies to boost HPL adherence and improve health outcomes for these patients.

Materials and Methods

Study Design and Participants

This cross-sectional study enrolled renal transplant recipients completing the revised Chinese HPLP at organ transplant center in a tertiary hospital in Hunan Province of China between May 2022 and July 2022. The inclusion criteria were: 1) individuals aged 18 years and above; 2) kidney transplant recipients who had a follow-up visit at our outpatient clinic; and 3) patients capable of collaborating in the completion of the questionnaire. The exclusion criteria were: 1) patients with combined organ transplantation; 2) patients with mental illness or health problems that could lead to cognitive impairment. This study was approved by the Institutional Review Board of Xiangya Hospital, Central South University (registration number: 2021101000). Each participant was informed of the purpose of the study and signed a written informed consent.

Sample Size Calculation

We calculated the required sample size using the following formula for a cross-sectional study design: where p represents the assumed prevalence, δ represents the allowable error (usually δ= 0.1p), and α represents the significance level of the statistical test. According to previous studies, lifestyle adherence among kidney transplant recipients is at a moderate level.[22] We conservatively estimated lifestyle adherence to be 50%. With p=50%, α=0.05, and δ=0.05, the minimum sample size for this survey is 384. Considering a response rate of 90%, we decided to recruit at least 427 post-kidney transplant recipients.

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta}\right) \times p \times (1 - p)$$

Variables and Assessment

Independent variables in the study were sociodemographic characteristics and medical information. Sociodemographic characteristics include sex, age, body mass index (BMI), education levels, marital status, monthly income, household type, and health behavior including smoking status before and after transplantation. Medical information includes the source of the donor's kidney, current immunosuppressants, antihypertensive drugs, hypoglycemic drugs, and post-transplantation complications. Post-transplantation complications refer to various adverse events or conditions that arise after kidney transplantation, including infections, rejection reactions, and surgical issues, among others. To evaluate the level of renal transplant recipients' HPL, a modified Chinese edition of HPLP was used in the study. The Health

Promotion Lifestyle Questionnaire was originally developed by Walker et al,[10] and has been translated into multiple languages and tested on different populations in different cultures.[23–26] This study used the Chinese version of the HPLP questionnaire developed by Chen et al,[22] which is widely used to measure individuals' health-promoting lifestyles. The Chinese version of the HPLP questionnaire has 40 entries, including six dimensions: nutrition, exercise, health responsibility, interpersonal support, self-actualization, and stress management (Supplementary Table 1). A four-point Likert scale (0=never, 1=sometimes, 2=usually, 3=always) was used to rate each item, with scores ranging from 0 to 120. A Higher score represents better HPL. According to a previous study,[21] a lifestyle score below 50% was defined as non-adherence and 50% and above as adherence. The Cronbach's alpha coefficient for this scale was 0.94, and the Cronbach's alpha coefficients for the six subscales were 0.90, 0.79, 0.84, 0.83, 0.77, and 0.74, respectively.

Data Collection

The researchers imported the Chinese version of the HPLP questionnaire into the Questionnaire Star online survey platform (https://www.wjx.cn/vj/hblsDkE.aspx), then freely created a QR code and posted it to the renal transplant patients' return visit WeChat group.[22] Demographic data and medical information were collected using face-to-face and one-on-one interviews. Height and weight were measured by the researchers at the clinic and used to calculate body mass index (BMI) in kg/m^2. Participants could scan the QR code to read and submit the informed consent agreement. After that, they could choose to fulfill the questionnaire, and each participant was allowed to submit only once to avoid double submissions. For participants with reading comprehension impairment, the questionnaire was completed under the guidance of the researcher. Researchers patiently answered any questions from the participants, checked the questionnaire submissions daily, and gave phone calls to verify abnormal data to ensure the integrity and validity of the data. In this study, a total of 457 kidney transplant recipients were invited to participate in the survey. After excluding invalid responses, we obtained 450 valid questionnaires with an effective response rate of 98.47%.

Statistical Analysis

All data were statistically analyzed using IBM SPSS 26.0. Mean (SD) was used to describe the continuous data. Categorical variables were described by the number of cases (N) and composition ratio. For dichotomous variables such as sex, household type, and smoking status after transplantation, independent samples *t*-test was used; for multi-category variables such as age, BMI, and education level, one-way analysis of variance (ANOVA) was used to test the differences in HPLP and the six subscale scores in different populations. Finally, to explore the potential factors influencing the health-promoting lifestyle of renal transplant patients, we included variables that proved to be statistically significant in between-group comparisons, and developed binary logistic regression models based on the dichotomous HPLP total score. If the results of univariate logistic regression models were statistically significant, multiple-stepwise logistic regression analysis was performed after adjusting for relevant covariates. All P-values were obtained from two-sided tests. All reported data were considered significant if $P < 0.05$.

Results

A total of 450 patients were included, comprising 256 males (56.9%), with a mean age of 44.85 ± 10.57 years. 26.9% were overweight or obese. 35.6% had college or higher education, 80.7% were married, and 50.4% lived in rural areas. 13.3% of the recipients started smoking within 1 to 2 years after surgery, and the amount of cigarettes smoked ranged from 1 to 20 cigarettes. The main reasons for transplantation were end-stage chronic renal disease due to chronic glomerulonephritis (258, 57.3%), hypertensive nephropathy (96, 21.3%), and IgA nephropathy (59, 13.1%). Cadaveric donors were the main source of donor kidneys (373, 82.9%). 78.5% of the participants were mainly on hemodialysis preoperatively to maintain the function of the original kidney, with more than half undergoing dialysis for less than 1 year. The mean transplantation time of the participants was 5.38 ± 4.57 years. 59.4% of the participants reported different types of complications after transplantation, such as hypertension, diabetes, hyperlipidemia, and rejection, with 16.2% combining 2 or more complications. The differences in overall HPLP levels were highly significant ($P \leq 0.01$) for education levels, household type, smoking status after transplantation, and post-transplant complications. HPLP was higher in females than in males ($P < 0.05$). Renal transplant recipients in the 46–59-year age group had significantly

higher differences in self-actualization, physical activity, nutrition, and overall HPLP scores than in other age groups ($P < 0.05$). In addition to interpersonal support, renal transplant recipients with a college degree or above had higher overall HPLP scores than those with a high school education or below, and the difference was significant ($P < 0.05$). The self-realization and physical activity scores in married patients were significantly higher compare to the unmarried population ($P < 0.05$). Low-income renal transplant recipients had significantly lower self-actualization and stress management scores than those with higher income ($P < 0.05$), and renal transplant recipients living in urban areas had higher HPLP levels than those living in rural areas ($P < 0.05$), especially in self-actualization, health responsibility, physical activity, stress management, nutrition, and overall HPLP ($P < 0.01$), which were more significant. Regarding smoking status, patients who smoked after transplantation had lower scores in self-actualization, health responsibility, interpersonal support, nutrition, and overall HPLP than nonsmokers, and the difference was statistically significant ($P < 0.05$). As the type of post-transplantation complications increased, patients' overall HPLP tended to decrease. When patients combined three or more complications, overall HPLP increased instead, especially they had the highest scores in health responsibility and overall HPLP ($P < 0.01$). Patients with two complications had the lowest scores in self-actualization, health responsibility, interpersonal support, stress management, and overall HPLP. However, we did not find a significant effect of current use of immunosuppressants, antihypertensive drugs, and hypoglycemic drugs on HPLP in renal transplant recipients (Table 1).

The mean score of self-actualization, health responsibility, interpersonal support, physical activity, stress management, nutrition, and overall HPLP were 15.27 ± 5.03 (possible range: 0–24), 11.41 ± 4.18 (possible range: 0–24), 11.61 ± 3.13 (possible range: 0–18), 7.53 ± 3.79 (possible range: 0–18), 12.68 ± 3.61 (possible range: 0–21), 11.17 ± 2.41 (possible range: 0–15), and 69.66 ± 16.98 (possible range: 0–120), respectively (Table 2). Among the six sub-scales, nutrition behaviors scored the highest, while physical activity scored the lowest. This means that kidney transplant recipients performed best on nutrition behaviors and worst on exercise behaviors.

Multivariate logistic regression analysis showed that urban residence (OR = 2.061, 95% CI: 1.350–3.148, P = 0.001), non-smoking after transplantation (OR = 2.010, 95% CI: 1.123–3.600, P = 0.019) and two post-transplant complications (OR=0.387, 95% CI: 0.218–0.689, P = 0.001) (Table 3). The literatures related to HPL in transplant recipients were showed in Supplementary Table 2. The STROBE checklist for the study is shown in the Supplementary Material.

Discussion

This study found that renal transplant recipients demonstrate a moderate level of HPL, necessitating targeted interventions to enhance these behaviors. Specifically, interventions should prioritize individuals from rural households, post-transplant smokers, and those grappling with post-transplant complications, aiming to enhance their quality of life and clinical outcomes.

This study's findings underscore the moderate HPL behaviors among Chinese renal transplant recipients, which is a critical insight for healthcare professionals and policymakers. The overall HPLP score of less than 70 reflects a behavior pattern that, while not negligible, leaves considerable room for enhancement.[12] The nutrition subscale's higher score indicates an awareness of the importance of diet among recipients, which is consistent with the emphasis on dietary management post-transplantation. However, this study also emphasizes the need for a balanced diet, as a significant number of recipients did not consume a diverse range of food groups daily. This calls for targeted nutritional counseling aimed at enhancing dietary diversity and ensuring recipients receive adequate nutrients to support their immune function and overall health.[12]

The results of this study showed relatively lower score in physical activity is a concern, as it aligns with global trends where physical activity is often neglected despite its proven benefits for transplant recipients.[27,28] The discrepancy in physical activity levels may be attributed to various factors, including the recipients' fear of jeopardizing their transplanted kidney through strenuous exercise, or the demanding nature of their post-transplantation recovery and regimen adherence, leaving little time for regular physical activity.[29] Moreover, this study's observation that only a small percentage of recipients fully comply with exercise behaviors highlights the need for tailored exercise interventions that are cognizant of the recipients' fears and daily routines. It is essential to develop educational programs that not only promote the benefits of physical activity but also provide practical solutions to overcome barriers to exercise adherence.[27]

Table 1 Demographic Characteristics and HPLP Scores

Variables (n=450)	Number of cases (%)	Self-Actualization	Health Responsibility	Interpersonal Support	Physical Activity	Stress Management	Nutrition	Overall HPLP
Sex								
Male	256 (56.9)	14.66 ± 5.09	11.05 ± 4.16	11.32 ± 3.07	7.47 ± 3.65	12.49 ± 3.61	10.93 ± 2.48	67.92 ± 17.12
Female	194 (43.1)	16.08 ± 4.84	11.89 ± 4.17	11.98 ± 3.17	7.60 ± 3.97	12.92 ± 3.60	11.48 ± 2.29	71.96 ± 16.56
t		−2.978	−2.122	−2.230	−0.372	−1.266	−2.450	−2.515
P		0.003	0.034	0.026	0.710	0.206	0.015	0.012
Age	44.85 ± 10.57							
18–31, year	40 (8.9)	13.40 ± 5.52	10.55 ± 3.68	11.55 ± 3.60	6.33 ± 3.70	12.98 ± 3.85	10.73 ± 2.61	65.53 ± 14.39
32–45, year	183 (40.7)	14.91 ± 5.06	11.16 ± 4.30	11.40 ± 3.12	6.81 ± 3.58	12.75 ± 3.64	10.75 ± 2.49	67.79 ± 17.43
46–59, year	199 (44.2)	15.98 ± 4.90	11.69 ± 4.13	11.86 ± 3.10	8.43 ± 3.87	12.62 ± 3.46	11.60 ± 2.32	72.19 ± 16.91
≥ 60, year	28 (6.2)	15.25 ± 4.33	12.32 ± 4.26	11.21 ± 2.54	7.50 ± 3.25	12.14 ± 4.18	11.46 ± 1.58	69.89 ± 15.94
F		3.551	1.540	0.857	7.655	0.340	4.664	3.049
P		0.015	0.203	0.463	<0.001	0.796	0.003	0.028
BMI, kg/m^2								
Normal weight (18·5 to < 24 kg/m^2)	278 (61.8)	15.25 ± 5.00	11.69 ± 4.20	11.62 ± 3.04	7.82 ± 3.77	12.73 ± 3.44	11.31 ± 2.43	70.42 ± 16.93
Underweight (< 18·5 kg/m^2)	51 (11.3)	13.51 ± 4.95	10.61 ± 4.10	10.82 ± 2.93	6.39 ± 3.47	11.47 ± 3.62	11.00 ± 2.33	63.80 ± 15.57
Overweight (24 to < 28kg/m^2)	98 (21.8)	16.04 ± 5.08	11.23 ± 4.08	12.02 ± 3.23	7.49 ± 3.94	13.08 ± 3.98	11.04 ± 2.36	70.91 ± 17.01
Obese (≥ 28 kg/m^2)	23 (5.1)	16.22 ± 4.61	10.57 ± 4.45	11.43 ± 3.88	6.65 ± 3.68	12.96 ± 3.61	10.39 ± 2.48	68.22 ± 18.87
F		3.168	1.430	1.673	2.520	2.403	1.276	2.464
P		0.024	0.233	0.172	0.057	0.067	0.282	0.062
Education level								
Junior high school or below	130 (28.9)	14.14 ± 5.26	10.68 ± 4.08	11.37 ± 3.18	7.09 ± 3.91	11.73 ± 3.56	10.95 ± 2.56	65.96 ± 17.51
High school	160 (35.6)	15.44 ± 4.73	11.09 ± 3.84	11.48 ± 2.90	7.08 ± 3.48	12.38 ± 3.30	10.91 ± 2.47	68.39 ± 15.48
College degree or above	160 (35.6)	16.02 ± 4.99	12.33 ± 4.44	11.94 ± 3.29	8.32 ± 3.88	13.74 ± 3.69	11.60 ± 2.17	73.95 ± 17.16
F		5.287	6.401	1.416	5.632	12.546	4.078	8.945
P		0.005	0.002	0.244	0.004	<0.001	0.018	<0.001
Marital status								
Single	56 (12.4)	13.77 ± 5.59	10.82 ± 4.34	11.23 ± 3.24	7.21 ± 4.50	12.91 ± 4.03	10.79 ± 2.79	66.73 ± 18.53
Married	363 (80.7)	15.58 ± 4.90	11.56 ± 4.18	11.72 ± 3.02	7.71 ± 3.65	12.69 ± 3.56	11.20 ± 2.35	70.46 ± 16.85
Divorced or Widowed	31 (6.9)	14.39 ± 5.06	10.77 ± 3.91	10.94 ± 4.03	5.94 ± 3.68	12.06 ± 3.37	11.52 ± 2.34	65.61 ± 14.77
F		3.714	1.146	1.377	3.392	0.567	1.052	2.129
P		0.025	0.319	0.253	0.035	0.568	0.350	0120
Per monthly income								
0~5000	313 (69.6)	14.91 ± 5.19	11.21 ± 4.18	11.51 ± 3.15	7.42 ± 3.86	12.33 ± 3.69	11.09 ± 2.47	68.47 ± 17.23
5001~10,000	104 (23.1)	15.75 ± 4.51	11.86 ± 4.01	11.81 ± 2.82	7.86 ± 3.39	13.28 ± 3.13	11.51 ± 2.15	72.06 ± 15.13
> 10,000	33 (7.3)	17.21 ± 4.62	11.94 ± 4.62	11.94 ± 3.77	7.48 ± 4.28	14.06 ± 3.72	10.79 ± 2.57	73.42 ± 19.14
F		3.779	1.213	0.557	0.514	5.440	1.613	2.631
P		0.024	0.298	0.573	0.599	0.005	0.200	0.073
Household type								
Urban	223 (49.6)	16.19 ± 4.88	12.04 ± 4.31	11.97 ± 3.24	8.48 ± 3.88	13.22 ± 3.68	11.56 ± 2.26	73.45 ± 17.04
Rural	227 (50.4)	14.37 ± 5.02	10.80 ± 3.96	11.26 ± 2.97	6.59 ± 3.45	12.15 ± 3.46	10.78 ± 2.50	65.94 ± 16.12
t		3.904	3.186	2.433	5.432	3.178	3.479	4.805
P		<0.001	0.002	0.015	<0.001	0.002	0.001	<0.001

(*Continued*)

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Table 1 (Continued).

Variables (n=450)	Number of cases (%)	Self-Actualization	Health Responsibility	Interpersonal Support	Physical Activity	Stress Management	Nutrition	Overall HPLP
Pre-transplant smoking								
No	315 (70.0)	15.50 ± 5.03	11.77 ± 4.02	11.76 ± 3.16	7.64 ± 3.81	12.78 ± 3.48	11.33 ± 2.34	70.78 ± 16.60
Yes	135 (30.0)	14.76 ± 5.02	10.57 ± 4.44	11.26 ± 3.03	7.25 ± 3.73	12.43 ± 3.88	10.79 ± 2.53	67.05 ± 17.62
t		1.431	2.823	1.556	1.008	0.947	2.208	2.145
P		0.153	0.005	0.120	0.314	0.344	0.028	0.032
Post-transplant smoking								
No	390 (86.7)	15.46 ± 4.94	11.66 ± 4.12	11.75 ± 3.08	7.65 ± 3.77	12.74 ± 3.52	11.33 ± 2.35	70.59 ± 16.66
Yes	60 (13.3)	14.07 ± 5.46	9.82 ± 4.23	10.70 ± 3.26	6.70 ± 3.86	12.27 ± 4.12	10.12 ± 2.53	63.67 ± 17.94
t		2.003	3.211	2.433	1.821	0.943	3.676	2.964
P		0.046	0.001	0.015	0.069	0.346	<0.001	0.003
Kidney donor source								
Living donor	77 (17.1)	14.27 ± 5.34	10.71 ± 4.17	11.22 ± 3.31	6.49 ± 3.67	12.79 ± 3.74	10.96 ± 2.45	66.45 ± 16.91
Cadaveric donor	373 (82.9)	15.48 ± 4.95	11.56 ± 4.17	11.69 ± 3.09	7.74 ± 3.78	12.65 ± 3.58	11.21 ± 2.40	70.33 ± 16.94
t		−1.923	−1.615	−1.198	−2.647	0.311	−0.822	−1.827
P		0.055	0.107	0.232	0.008	0.756	0.411	0.068
Current immunosuppressants								
Cyclosporine	35 (7.8)	16.03 ± 5.35	11.29 ± 3.79	11.31 ± 3.45	8.49 ± 4.49	13.23 ± 3.83	11.66 ± 1.96	72.00 ± 17.36
Tacrolimus	415 (92.2)	15.21 ± 5.00	11.42 ± 4.22	11.63 ± 3.10	7.45 ± 3.72	12.63 ± 3.59	11.13 ± 2.44	69.47 ± 16.96
t		0.925	−0.188	−0.580	1.563	0.945	1.255	0.847
P		0.356	0.851	0.562	0.119	0.345	0.210	0.397
Current antihypertensive medication								
No	117 (26.0)	15.37 ± 4.77	11.29 ± 3.95	11.57 ± 3.16	7.82 ± 4.09	12.46 ± 3.23	11.32 ± 2.57	69.83 ± 15.93
1 type	198 (44.0)	15.39 ± 5.34	11.57 ± 4.39	11.79 ± 3.17	7.70 ± 3.70	12.78 ± 3.82	11.16 ± 2.38	70.40 ± 18.00
2 type	110 (24.4)	15.15 ± 4.92	11.40 ± 4.19	11.32 ± 2.96	7.16 ± 3.85	12.90 ± 3.57	11.14 ± 2.30	69.07 ± 16.55
≥3 type	25 (5.6)	14.44 ± 4.30	10.80 ± 3.58	11.60 ± 3.34	6.36 ± 2.27	11.84 ± 3.71	10.64 ± 2.46	65.68 ± 15.47
F		0.296	0.306	0.550	1.510	0.784	0.553	0.629
P		0.828	0.821	0.648	0.211	0.503	0.646	0.597
Current Antidiabetic medication								
No	388 (86.2)	15.24 ± 5.04	11.31 ± 4.14	11.62 ± 3.10	7.42 ± 3.76	12.63 ± 3.54	11.14 ± 2.45	69.36 ± 16.85
Oral hypoglycemic drugs	40 (8.9)	15.13 ± 5.04	12.33 ± 4.35	11.08 ± 3.52	8.15 ± 3.79	12.85 ± 3.87	11.18 ± 2.23	70.70 ± 17.28
Insulin	18 (4.0)	16.72 ± 5.15	12.06 ± 4.81	12.39 ± 3.11	8.89 ± 4.19	13.33 ± 4.59	11.72 ± 2.14	75.11 ± 20.51
Both	4 (0.9)	13.50 ± 3.70	9.75 ± 3.10	12.50 ± 0.58	5.25 ± 3.30	12.25 ± 3.10	11.25 ± 0.50	64.50 ± 5.20
F		0.680	1.072	0.872	1.726	0.267	0.336	0.831
P		0.565	0.361	0.456	0.161	0.849	0.799	0.477
Post-transplantation complication								
No	183 (40.7)	16.22 ± 5.11	11.25 ± 4.27	11.87 ± 3.14	7.73 ± 4.02	13.08 ± 3.52	11.32 ± 2.37	71.47 ± 17.06
1 type	142 (31.6)	14.77 ± 4.93	11.52 ± 4.02	11.72 ± 3.10	7.63 ± 3.33	12.60 ± 3.48	11.07 ± 2.50	69.31 ± 15.87
2 type	73 (16.2)	13.73 ± 4.91	10.49 ± 4.25	10.60 ± 3.08	6.59 ± 3.80	11.60 ± 4.05	11.03 ± 2.49	64.04 ± 18.33
≥3 type	52 (11.6)	15.50 ± 4.56	13.00 ± 3.83	11.79 ± 3.02	7.83 ± 4.02	12.98 ± 3.34	11.08 ± 2.18	72.17 ± 16.30
F		5.107	3.880	3.121	1.773	3.096	0.434	3.828
P		0.002	0.009	0.026	0.154	0.027	0.729	0.010

Table 2 HPLP Domain and Total Scores

Domain	Items	Score	Average Score of Each Domain	Average Score of Each Item	Rank
Self-actualization	8	0~24	15.27 ± 5.03	1.91 ± 0.63	3
Health responsibility	8	0~24	11.41 ± 4.18	1.43 ± 0.52	5
Interpersonal support	6	0~18	11.61 ± 3.13	1.93 ± 0.52	2
Physical activity	6	0~18	7.53 ± 3.79	1.25 ± 0.63	6
Stress management	7	0~21	12.68 ± 3.61	1.81 ± 0.52	4
Nutrition	5	0~15	11.17 ± 2.41	2.23 ± 0.482	1
Overall HPLP	40	0~120	69.66 ± 16.98		

Table 3 Participants' HPLP-Related Exposures

Variables	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Sex				
Male	Ref.			
Female	1.577 (1.043,2.385)	0.031		
Age, year				
18–31	Ref.			
32–45	0.911 (0.445,1.863)	0.798		
46–59	1.648 (0.798,3.405)	0.177		
≥ 60	1.615 (0.552,4.729)	0.382		
BMI				
Normal weight (18.5 to < 24 kg/m²)	Ref.			
Underweight (< 18.5 kg/m²)	0.587 (0.318,1.086)	0.090		
Overweight (24 to < 28 kg/m²)	1.081 (0.647,1.806)	0.766		
Obese (≥28 kg/m²)	0.640 (0.266,1.537)	0.318		
Education level				
Junior high school or below	Ref.	–		
High school	1.155 (0.713,1.870)	0.558		
College degree or above	2.242 (1.334,3.767)	0.002		
Marital status				
Single	Ref.			
Married	1.713 (0.960,3.055)	0.068		
Divorced or Widowed	1.464 (0.582,3.681)	0.418		
Per monthly income				
0~5000	Ref.	–		
5001~10,000	1.659 (0.993,2.771)	0.053		
> 10,000	1.144 (0.525,2.494)	0.734		
Household type				
Rural	Ref.			
Urban	2.096 (1.389,3.162)	<0.001	2.061 (1.350,3.148)	0.001
Pre-transplant smoking				
Yes	Ref.			
No	1.591 (1.038,2.438)	0.033		
Post-transplant smoking				
Yes	Ref.			
No	2.057 (1.182,3.579)	0.011	2.010 (1.123,3.600)	0.019

(*Continued*)

Table 3 (Continued).

Variables	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Kidney donor source				
Living donor	Ref.			
Cadaveric donor	1.463 (0.877,2.442)	0.145		
Post-transplant complications				
No	Ref.			
1 type	0.952 (0.585,1.547)	0.842	1.029 (0.626,1.693)	0.910
2 type	0.376 (0.214,0.659)	0.001	0.387 (0.218,0.689)	0.001
≥3 type	1.846 (0.840,4.058)	0.127	1.777 (0.799,3.952)	0.158

Note: Bold text indicates that the information is highlighted. Italics are used for P values.

Furthermore, this study's findings on the low compliance with stretching exercises and relaxation activities suggest that recipients may benefit from integrated lifestyle programs that combine physical activity with stress management techniques, such as yoga or pilates, which are less intensive and can be more easily incorporated into a busy schedule.[29] The psychological barriers to physical activity, including the fear of transplant rejection or complications, can be addressed through counseling and support groups, where recipients can share their experiences and learn from peers who have successfully adopted health-promoting lifestyles.[28] Additionally, the influence of socio-demographic factors on health-promoting lifestyles should be considered when designing such interventions, as they may affect the recipients' willingness and ability to engage in health-promoting activities.[30]

The significance of a healthy lifestyle in enhancing life expectancy cannot be overstated, as evidenced by the observed correlation between lifestyle habits and longevity. Previous study reinforces the notion that a healthy lifestyle profoundly influences life expectancy, a concept particularly pertinent to renal transplant recipients.[31] Their research indicates that adherence to 5 key health behaviors can lead to an 8–9 year longer life expectancy, emphasizing the importance of patient education on lifestyle choices. Zhang et al add a layer of specificity, noting that urban living transplant recipients, with better access to resources and education, tend to have higher HPLP.[29] This suggests that creating environments conducive to health is as critical as the medical care provided. Regular health assessments can further mitigate lifestyle-related complications, underscoring the need for a holistic approach to patient care that addresses both health status and lifestyle.

The detrimental impact of smoking on the health of kidney transplant recipients is well-documented, with significant consequences on both patient and graft survival rates. As highlighted in the systematic review by Nourbala et al, smoking is a recognized independent risk factor for patient death and graft failure, with a relative risk for graft failure ranging from 1.06 to 2.3.[32] This is corroborated by the study's findings that non-smoking post-transplantation enhances adherence to the HPLP. The metabolic syndrome (MetS), a cluster of conditions that increase the risk of heart disease, stroke, and diabetes, is 1.26 times more likely to develop in smokers than non-smokers, as indicated in the review by Kim et al.[28] Smoking not only triggers sympathetic nervousness, leading to increased blood pressure and insulin resistance, but it also causes kidney damage through ischemia or fibrosis, thereby harming the transplanted organ. Furthermore, it is identified as a risk factor for early pulmonary complications following kidney transplantation. To mitigate these risks, it is imperative for renal transplant recipients to be educated on the hazards of smoking and to adopt strategies to quit, such as deep breathing, hydration, dental hygiene, and the use of alternative methods like chewing gum and vegetables, complemented by moderate-intensity aerobic exercise. This comprehensive approach can significantly improve their HPL levels and overall health outcomes.

Post-transplant complications, notably overweight/obesity and a history of hypertension, significantly impede HPLP adherence among renal transplant recipients. A considerable percentage of recipients-26.90%-were overweight or obese, with 21.3%, 4.7%, and 3.6% reporting a history of hypertension, diabetes, and polycystic kidney disease, respectively. The majority, 92.2%, were on tacrolimus, 74% took anti-hypertensives, and 13.8% required glucose-lowering drugs or

insulin. These factors predispose recipients to diabetes, dyslipidemia, and cardiovascular disease, with the latter posing a 20.8 folds higher mortality risk post-transplant compared to the general population.[33] Poor dietary and lifestyle habits further escalate the risks of hypertension, diabetes, and hyperlipidemia. Interestingly, as complication numbers rise, the overall HPLP score declines, with those having two complications recording the lowest scores. However, a paradoxical increase in HPLP levels is observed when complications exceed three. This aligns with Kenawy et al's findings, suggesting that recipients may initially underestimate the preventive power of a healthy lifestyle.[34] Yet, as the severity of their health issues becomes apparent, they become more receptive to medical advice and proactive in managing their conditions, thus gradually improving their HPLP adherence. This underscores the necessity for healthcare professionals to integrate HPL considerations into the treatment plans of renal transplant recipients. It is crucial to address and correct any misconceptions about HPL and ensure recipients are well-versed in its benefits before their discharge.

This study is not without limitations. First, this was a cross-sectional study and HPL prevalence could not be calculated to establish a causal relationship. Second, the questionnaire was partially derived from self-reports of renal transplant recipients and lacked qualitative analysis, and the observed and actual HPL levels may be slightly different. Finally, the results of this study have limited generalizability and were only conducted in renal transplant recipients from a single transplant center. Therefore, follow-up studies should use a combination of qualitative and quantitative methods, while measuring objective indicators related to HPL. In addition, the influence of relevant factors on HPL should be accurately analyzed by longitudinal studies to clarify the trajectory of renal transplant recipients on HPL.

In conclusion, the current state of health-promoting lifestyles among renal transplant recipients is moderate, yet there is considerable scope for enhancement. This study has successfully delineated a high-risk cohort within the kidney transplant community, a distinction that holds significant implications for public health initiatives. It is thus advised that governmental agencies collaborate with healthcare providers to enhance the monitoring of kidney transplant recipients. Proactive measures should be taken to implement lifestyle modification programs aimed at encouraging recipients to embrace healthier practices. The ultimate goal is to avert complications associated with suboptimal health-promoting lifestyles, thereby improving the quality of life and clinical outcomes for this patient population.

Data Sharing Statement

Data were available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Institutional Review Board of Xiangya Hospital, Central South University (registration number: 2021101000). All kidneys were donated voluntarily with written informed consent, and that this was conducted in accordance with the Declaration of Istanbul.[35] All the procedures were followed in accordance with the Declaration of Helsinki.[36] Each participant was informed of the purpose of the study and signed a written informed consent.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interest in this work.

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