

Physical Activity and Mental Health among Rural Older Adults: The Mediating Role of Social Connectedness

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Abstract

To understand the physical activity, social network connectedness, and mental health status of rural older adults, and to examine whether social networks show an indirect association between physical activity and mental health. Standardized quality control was applied to 61 pre-specified questionnaires. To understand physical activity, social network connectedness, and mental health status inclusion criteria and global physical activity questionnaire (GPAQ) scoring rules, yielding a descriptive-analysis sample of 60 respondents and a valid total-physical-activity sample of 55. Spearman correlation, Cronbach's alpha, robust linear regression, and mediation path analysis with 10,000 bias-corrected bootstrap replications were employed. The primary outcome was World Health Organization-five (WHO-5) well-being index. The secondary outcome was patient health questionnaire (PHQ)-9 depressive symptoms. Models were adjusted for age, gender, household economic status, and degree of activity limitation. The median total physical activity was 5040 metabolic equivalent (MET)-min/week, with 44 out of 55 (80.0%) reaching 600 MET-min/week. The median daily sedentary time was 422.5 minutes. Lubben social network scale (LSNS)-6 was 15.5 ± 6.2 , with 12 out of 60 (20.0%) in the priority range for social isolation. PHQ-9 was 7.85 ± 6.58 , with 21/60 (35.0%) reaching the moderate-or-above screening level. WHO-5 was 63.7 ± 26.2 , with 19 out of 60 (31.7%) in the priority support range for poor well-being. WHO-5 was correlated with PHQ-9, and all three scales showed high internal consistency. The adjusted indirect effect was 1.07 points (95% confidence interval -0.29 to 4.42) for WHO-5 and -0.26 points (95% confidence interval -1.01 to 0.06) for PHQ-9, both in the direction consistent with improved mental health. This survey effectively characterized the activity structure, social connectedness, and mental health needs of rural older adults. Scale reliability, the convergent relationship between the two psychological indicators, and multiple robustness checks jointly support the applied value of the findings. The study develops a practical pathway from needs identification and priority-group targeting to companion-based activities, primary-level screening, stratified referral, and periodic re-assessment, which can serve the design of the "Three Going to the Countryside" program and grassroots health actions.

Keywords

Rural older adults, Physical activity, Social networks, Mental health

Introduction

Population aging is profoundly reshaping health service demand in urban and rural China. The Seventh National Population Census showed that people aged 60 years and above already account for 18.7% of the population. As people enter old age, chronic disease management, functional maintenance, social participation, and psychological care have gradually become shared concerns of health governance [1]. National arrangements on aging work in the new era and on aging affairs in the 14th Five-Year Plan further emphasize healthy aging, accessibility of grassroots services, and

the building of an age-friendly society [2-3]. In rural areas, population mobility, shifting family structures, transformed production and lifestyles, and expanding public service coverage interact with one another. For this reason, researchers need to understand older adults' physical activity, social interaction and psychological state through field surveys rooted in village life.

Physical activity is an important modifiable factor throughout the entire process of health promotion for older adults. World Health Organization guidelines state that older adults should maintain regular aerobic activity

as their ability and health conditions allow, combined with muscle-strengthening, balance, and functional training.

Systematic research also shows that adequate activity is closely associated with cardiovascular health, physical function, emotional state, and quality of life [4-6]. Whether physical activity can be sustained depends not only on personal willingness but also on physical function, social support, environmental conditions, and activity opportunities [7]. China's National Fitness Plan (2021-2025) likewise stresses improving fitness services for older adults and community-level sports organizations, providing a policy basis for village-level health promotion [8].

Physical activity among rural older adults is distinctly composite in nature. Agricultural labor, housework, caregiving, walking for transport, and leisure exercise may all coexist, differing in intensity, duration, recovery needs, and social attributes.

Therefore, a simple measure of "whether one exercises" can hardly reflect the true structure of activity. This survey adopted standardized tools to measure activity volume in various domains. It also recorded sedentary behavior, activity limitations, fall history, and the social context of leisure activities. These data help address practical research questions: Where physical activity originates, whether it meets health-enhancing thresholds, which groups require safety stratification, and how productive labor can be balanced with purposeful exercise.

Sedentary behavior is an independent entry point that cannot be ignored in activity interventions. Some older adults may sit or lie down for long periods outside working hours even when their cumulative activity volume is high, and heavy labor does not equate to well-structured healthy exercise. Building on this understanding, the survey examined two goals in tandem: sustaining regular physical activity and cutting prolonged sedentary time. It considered both the overall foundation of physical activity and small, achievable daily improvements. Such improvements include short standing breaks, walking, stretching, and balance training. This design ensures that the resulting recommendations align with the daily routines of rural older adults.

Social network connectedness may be an important social pathway linking physical activity and mental

health. Stable family, neighbor, and friend relationships can provide companionship, emotional support, health information, mutual care, and participation norms; high-quality social relationships are consistently associated with health and survival outcomes [9]. For older rural adults, acquaintance networks may further lower the psychological threshold for joining activities and enhance the sense of safety and persistence.

Accordingly, this survey focused on two dimensions. The first is "how much one moves". The second covers "with whom one moves, whether participation remains stable, and whether communication and mutual aid emerge during activities". It also examined the mediating role of social networks in the links between physical activity, well-being and depressive symptoms. Mental health is both an important component of health in old age and a key outcome for evaluating the effectiveness of health promotion.

Changes in physical function, chronic disease, widowhood and living alone, family members working away from home, and shifts in social roles can all affect older adults' mood and subjective well-being. This study adopted two measurement tools.

The PHQ-9 identifies depressive risk based on symptom assessment, while the WHO-5 evaluates well-being from a positive psychology perspective. Together, they form complementary observation frameworks. Moreover, these results help translate group characteristics into actionable guidance for priority screening, stratified support, and ongoing follow-up.

Accordingly, this survey was organized around three interlocking questions: First, what are the levels of physical activity, sedentary behavior, social networks, and mental health among rural older adults? Second, what correlations and pathway characteristics exist among physical activity, social connectedness, and mental health? Third, how can statistical findings be translated into health promotion recommendations? These recommendations should be executable at the village level, connectable at the grassroots level, and evaluable over time.

The analytical framework also responds to the orientation of the WHO Global Action Plan on Physical Activity and "Healthy China 2030" toward whole-population, whole-life-course health promotion [10,11]. Oriented toward the practical decision-making of the

“Three Going to the Countryside” social practice program, this report integrates standardized investigation, statistical analysis, and the translation of findings. The survey generated a quantitative profile of physical activity, social connectedness, and mental health among participants. It identified key service priorities, including psychological support, sedentary interruption, activity safety stratification, and companion-led group activities. It also put forward targeted implementation recommendations for relevant practitioners. These recommendations can be integrated into routine village doctor follow-up, older adult health management, and community volunteer services for residents. In this way, this cross-sectional survey can evolve into health promotion tools with sustained practical value.

Survey design and statistical methods

Participants and questionnaire instruments

The source file contained 61 responses. All respondents selected age ≥ 60 on the screening question, but the actual age field showed that one person was below 60, so the descriptive analysis included 60 respondents. The questionnaire covered basic information, GPAQ, the social context of leisure physical activity, the abbreviated LSNS-6, PHQ-9, WHO-5 and a healthy-lifestyle module. The GPAQ, LSNS-6, PHQ-9, and WHO-5 all have clear development or validation bases [12-15].

Variable operationalization

Please refer to Figure 1, 2 and Table 1 below for further details.

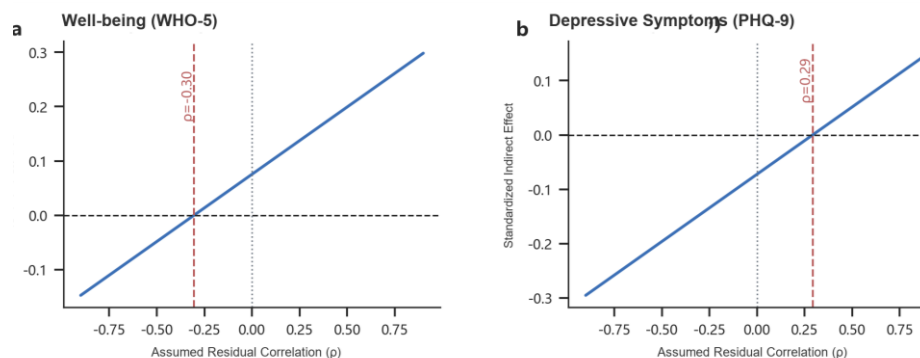


Figure 1. Robustness curves of the indirect effect under different residual-correlation scenarios. The red dashed line marks the residual correlation at which the indirect effect becomes zero.

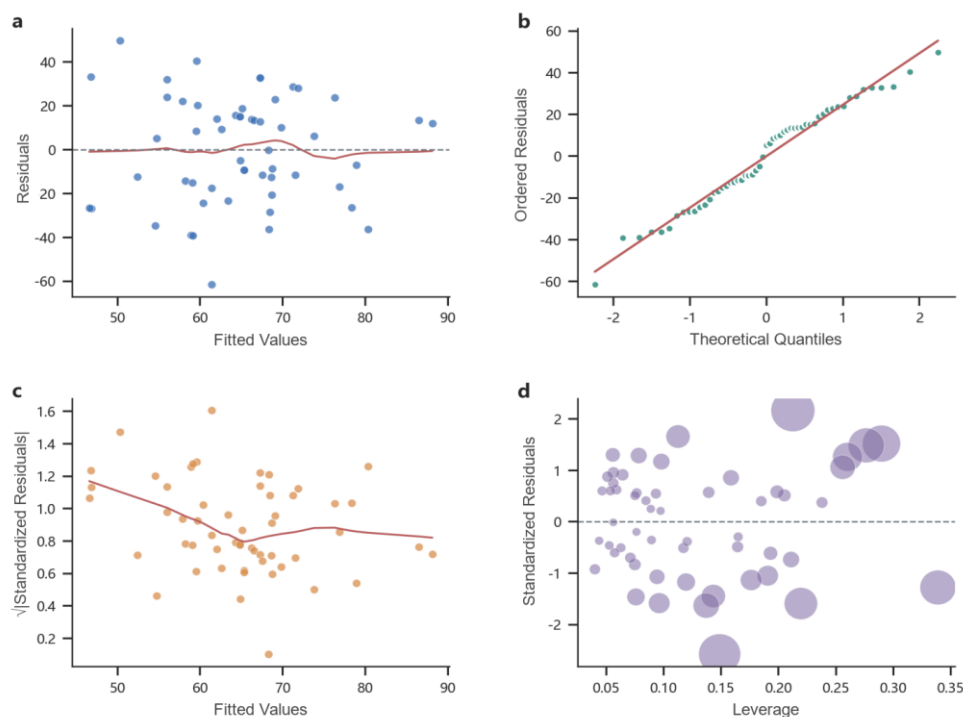


Figure 2. Residual, normal Q-Q, scale-location and influence-point diagnostics for the adjusted WHO-5 model.

Table 1. Operationalization and scoring rules of core variables.

Variable role	Instrument	Scoring and cleaning	Use in this report
Physical activity (X)	GPAQ	Vigorous work, moderate work, transport, vigorous leisure, and moderate leisure activities assigned 8/4 METs; MET-min/week computed; total activity averaging >960 min/day judged invalid	Main analysis uses $\log(1+\text{MET-min/week})$
Social network (M)	LSNS-6	6 items scored 0-5 each, total 0-30; higher scores indicate stronger network connectedness	<12 defined as social isolation risk
Depressive symptoms (Y1)	PHQ-9	9 items scored 0-3 each, total 0-27; higher scores indicate more severe symptoms	≥ 10 used as the moderate-or-above screening threshold; not a clinical diagnosis
Well-being (Y2)	WHO-5	5 items scored 0-5 each; raw total multiplied by 4 to convert to 0-100	≤ 50 indicates poor well-being
Covariates	Basic information and health status from the questionnaire	Age, gender, household economic status, degree of activity limitation	A concise pre-specified adjustment set was adopted given the sample size

Data quality control

The survey established a complete quality-control chain covering raw data protection, anonymization, scale scoring, and range verification. The original workbook remained read-only. The analysis scripts stripped platform metadata and exported only anonymous derived variables. GPAQ data were standardized for days, duration, and MET assignments following international analytical guidelines. Missing scale items and skip patterns were processed in line with questionnaire logic. According to the pre-specified rules, a descriptive-analysis sample of 60 and a valid GPAQ analysis sample of 55 were ultimately formed. In addition, a “fully completed and good-quality” sample was set up for robustness verification. Stratified samples, unified scoring, and full-process audit trails improved the consistency, reproducibility.

Statistical analysis

Continuous variables were described as mean $\pm$ standard deviation or median (interquartile range), and categorical variables as counts and percentages. The physical activity distribution was markedly skewed, so Spearman rank correlation was used for correlation analysis. The 21 correlation tests were controlled for the false discovery rate using the Benjamini-Hochberg method. Scale

internal consistency was assessed with Cronbach’s alpha, with 95% confidence intervals obtained from 2,000 bootstrap replications.

The mediation model adopted the product-of-coefficients approach: Physical activity predicted LSNS-6 as a path, and LSNS-6 together with physical activity predicted mental health as the b or c paths. The indirect effect a x b was estimated with 10,000 bias-corrected bootstrap replications. Effects are reported as changes in original scale scores corresponding to physical activity moving from the 25th to the 75th percentile, with standardized effects also provided.

The adjusted models included age, gender, household economic status, and degree of activity limitation, and the regressions used health consciousness (HC3) robust standard errors. Interpretation and reporting followed the AGRReMA recommendations for mediation analyses and the STROBE guidelines for observational studies [16,17].

Sample profile

The 60 included respondents had a mean age of 69.5 ± 9.2 years (median 66.0). 40 out of 60 (66.7%) were male. 75.0% of respondents had junior high school education or below, 30.0% self-reported household economic difficulty or considerable difficulty, and 41.7% reported at least one chronic disease.

Table 2. Main sample characteristics.

Characteristic	Result
Age (years)	69.5±9.2
Male	40 (66.7%)
Married with living spouse	52 (86.7%)
Junior high school or below	45 (75.0%)
Household economically difficult or somewhat difficult	18 (30.0%)
At least one chronic disease	25 (41.7%)
Moderate or greater activity limitation	14 (23.3%)
At least one fall in the past 12 months	15 (25.0%)
Participates in non-sports group activities at least once a week	18 (30.0%)

Among the 60 respondents, 34 engaged in agricultural, forestry, or breeding labor. 18 undertook housework, 16 cared for family members. 10 still had paid work. 8 participated in volunteer service and 20 reported being retired with no regular labor.

The survey effectively captured an activity structure in which productive labor, family responsibilities, social participation, and leisure exercise coexist, providing a realistic basis for designing health activities by category. In the past four weeks, 40 people engaged in leisure physical activity, among whom walking or brisk walking was the most common (26 people), followed by square dancing or aerobics (8 people).

Among the 40 participants, 27 were mainly active together with family, friends, or neighbors, showing that acquaintance society provides a good social foundation for the development of companion-based physical activity among local residents. Existing participants can serve as the first cohort of backbone members for fixed groups, exercise-buddy schemes, and village-level health activities.

Main statistical results

Levels of physical activity, social networks, and mental health

Further details are presented in Table 3.

Table 3. Description of core indicators.

Indicator	Level	Threshold or practical interpretation
GPAQ total physical activity	Median 5040 (1320-8820) MET-min/week	80.0% reached ≥ 600 MET-min/week
Sedentary time	Median 422.5 (360-540) min/day	About 7.0 hours/day
LSNS-6	15.5±6.2	20.0% below 12
PHQ-9	7.85±6.58	35.0% reached the moderate-or-above screening level
WHO-5	63.7±26.2	31.7% with poor well-being

The median GPAQ total physical activity was 5040 MET-min/week, with the 25th and 75th percentiles at 1320 and 8820 respectively. 44 out of 55 (80.0%) reached the 600 MET-min/week threshold recommended by global health guidelines, indicating a relatively good activity base in the sample of community respondents. The median sedentary time was 422.5 minutes/day, on the basis of which the survey further clarified the composite intervention direction of “maintaining adequate activity, distinguishing labor from exercise, and regularly interrupting sedentary time” to reduce prolonged sitting-related health hazards.

LSNS-6 averaged 15.5, with 12 out of 60 (20.0%) below

12, which suggests a small proportion of participants faced insufficient social connection within their daily neighbourhood networks. PHQ-9 averaged 7.85, with 21 out of 60 (35.0%) reaching the moderate-or-above screening level and requiring targeted mental support.

WHO-5 averaged 63.7, with 19 out of 60 (31.7%) at or below 50, signalling notable mental wellbeing risks. Cronbach’s alpha values of LSNS-6, PHQ-9, and WHO-5 were 0.941, 0.954, and 0.963 respectively, indicating high internal consistency in this sample and reliable measurement outcomes for all adopted scales used in this cross-sectional investigation. See Figure 3 for details.

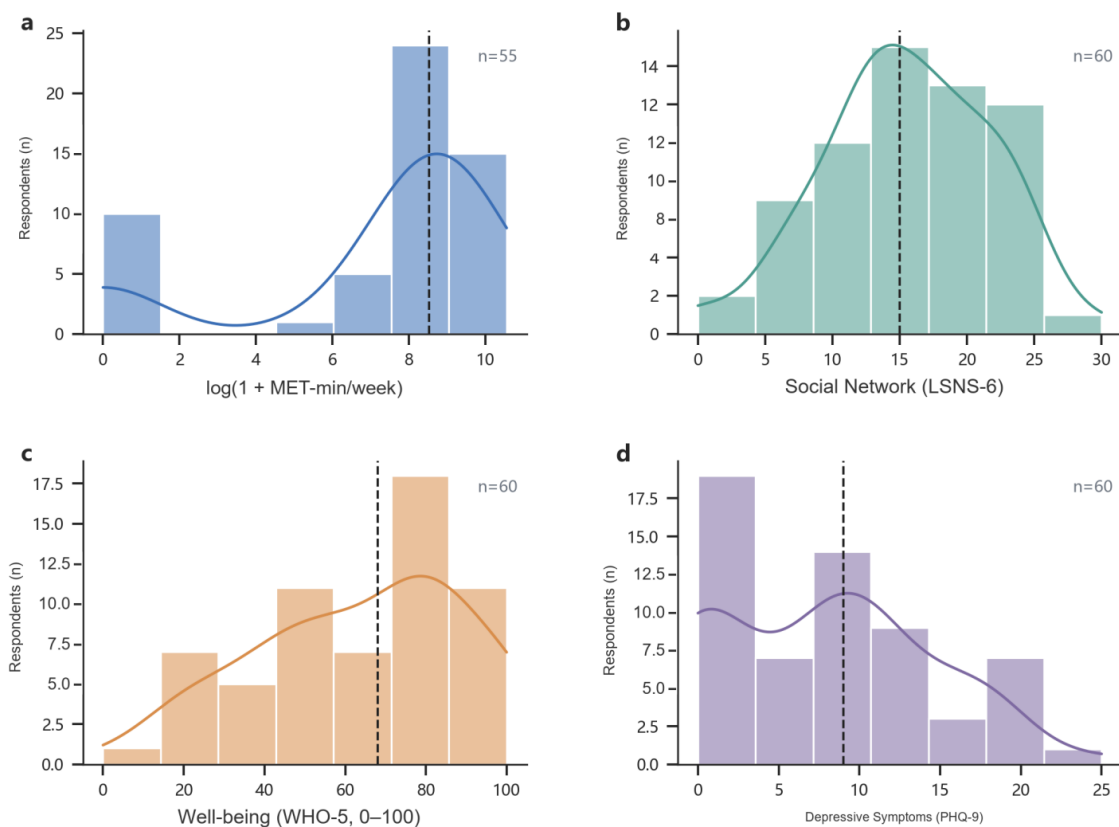


Figure 3. Distributions of total physical activity, social networks, WHO-5, and PHQ-9. Dashed lines indicate medians and total physical activity is shown as $\log(1 + \text{MET-min/week})$.

Correlations

Table 4 shows the spearman correlations of core variables.

Table 4. Spearman correlations of core variables.

Variable pair	Spearman ρ	p value	FDR q value	Interpretation
Total physical activity - social network	-0.246	0.070	0.245	Exploratory direction; provides clues for activity stratification
Total physical activity - WHO-5	-0.041	0.768	0.849	Weak association; suggests joint analysis by activity type
Total physical activity - PHQ-9	0.110	0.423	0.592	Weak association; supports a comprehensive intervention perspective
Social network - WHO-5	-0.249	0.055	0.231	Exploratory direction; reflects rural contextual complexity
Social network - PHQ-9	0.220	0.091	0.274	Exploratory direction; supports further stratified services
WHO-5 - PHQ-9	-0.722	<0.001	<0.001	Strong negative correlation; supports convergence of the two scales

WHO-5 and PHQ-9 showed a strong negative correlation ($\rho = -0.72$, FDR $q < 0.001$), indicating that the two mental health instruments obtained highly consistent information, providing strong support for the internal validity of the screening results. Physical activity, social

networks, and mental health showed multi-dimensional exploratory associations, indicating that the physical and mental health of rural older adults is not determined by activity volume alone. This result effectively prompts the practice team to pay simultaneous attention to activity

type, companionship mode, organizational participation, sedentary behavior, and physical function.

See Figure 4 for details about spearman correlation matrix of core variables.

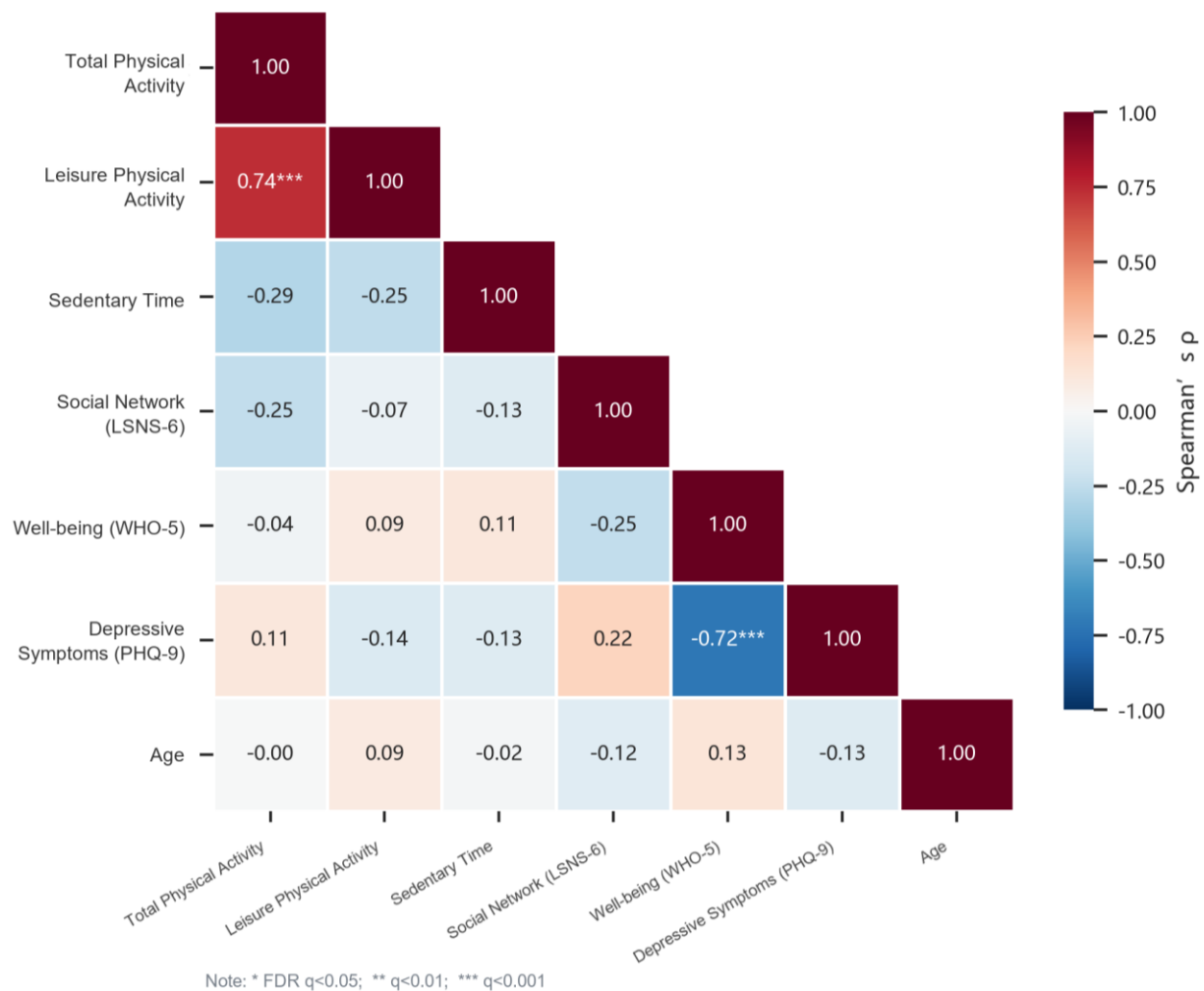


Figure 4. Spearman correlation matrix of core variables. Asterisks are based on Benjamini-Hochberg FDR correction.

Mediation model of social networks

Table 5. Indirect effects of social network connectedness.

Model	N	IQR indirect effect	95% CI	p value	Interpretation
WHO-5 (adjusted)	55	1.07 points	-0.29 to 4.42	0.220	Direction consistent with improved well-being; CI includes 0
PHQ-9 (adjusted)	55	-0.26 points	-1.01 to 0.06	0.211	Direction consistent with reduced symptoms; CI includes 0
WHO-5 (strict-quality sample)	35	0.55 points	-0.51 to 4.40	0.404	Direction remains consistent
PHQ-9 (top 5% of activity excluded)	52	-0.28 points	-1.20 to 0.11	0.247	Direction remains consistent

In the adjusted models, as physical activity increased from the 25th percentile (1320 MET-min/week) to the 75th percentile (8820 MET-min/week) in Table 5, the indirect change in WHO-5 via LSNS-6 was 1.07 points (95% CI -0.29 to 4.42), and the indirect change in PHQ-

9 was -0.26 points (95% CI -1.01 to 0.06). The two estimates respectively represent directional signals of improved well-being and reduced depressive symptoms. The path coefficients (in Figure 5) further showed that the social connectedness and activity patterns of rural

older adults have distinct contextual characteristics. The survey therefore not only tested the pre-specified pathway but also identified new leads that need to be

interpreted, companionship quality, and organizational participation, providing richer evidence for subsequent refined interventions.

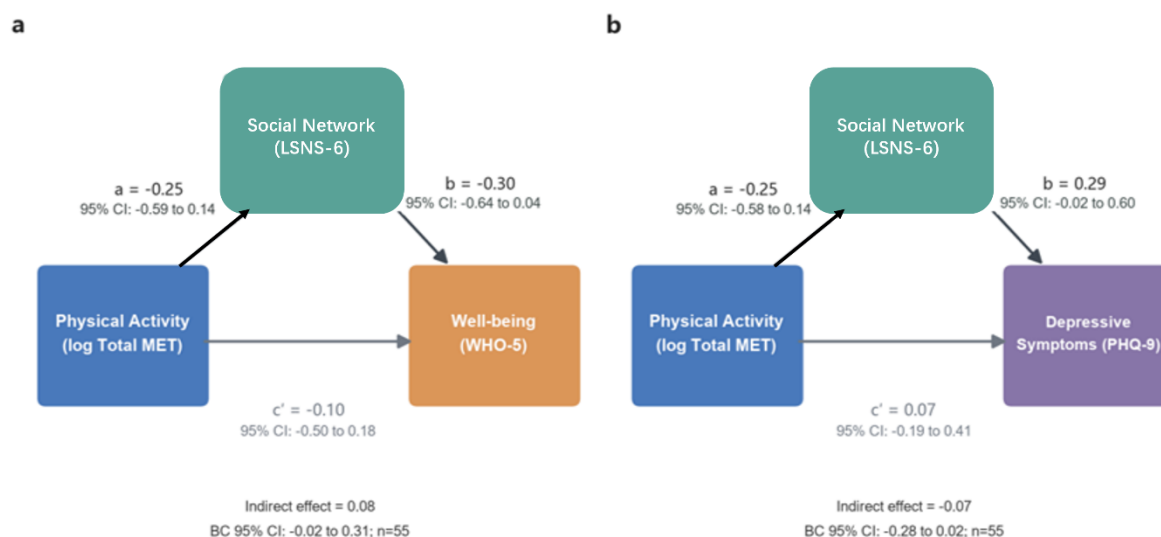


Figure 5. Adjusted mediation paths (Coefficients are standardized estimates, confidence intervals are bias-corrected bootstrap 95% confidence intervals, adjusted for age, gender, household economic status, and degree of activity limitation).

Robustness and model validation

After replacing total physical activity with leisure activity, restricting the sample to complete and good-quality questionnaires (WHO-5 model $N=35$), or excluding the top 5% of records by physical activity ($N=52$), the main results remained directionally consistent overall. The WHO-5 regression residuals were approximately normal, the Breusch-Pagan test gave $P=0.058$, and all non-intercept variance inflation factor (VIFs) were below 1.3. Multiple analytical schemes, good collinearity indicators, and standardized residual diagnostics jointly support the robustness of the analytical process.

Survey outcomes and practical value

Effective identification of mental health service needs

Through bidirectional measurements with the PHQ-9 and WHO-5, the survey identified 21 out of 60 (35.0%) reaching the PHQ-9 moderate-or-above screening level and 19 out of 60 (31.7%) entering the WHO-5 priority support range. The two indicators were strongly negatively correlated, and both scales had high internal consistency, indicating that the survey can reliably identify mental health service needs.

29 out of 60 (48.3%) reported non-zero scores on PHQ-9 Item 9. This finding provides the project team with

priority service leads for early screening, professional assessment, and ongoing follow-up. It allows questionnaire results to be directly linked to grassroots mental health support and routine health management.

Effective definition of activity intervention priorities

Among valid GPAQ respondents, 44 out of 55 (80.0%) met the widely accepted physical activity threshold. This indicates a relatively good baseline level of physical activity. The median sedentary time was 422.5 minutes per day. In addition, 23.3% of participants reported moderate or higher activity limitations, and 25.0% experienced at least one fall in the previous 12 months. On this basis, the survey accurately defined four intervention priorities: maintaining activity, reducing sedentary time, balance training, and health stratification.

Validating the social foundation of group-based activity

Among leisure-activity participants, 27 were mainly active together with family, friends, or neighbors, and walking, brisk walking, square dancing, and aerobics already had a good mass base. This finding supports relying on acquaintance networks to establish fixed activity times, exercise buddies, and village-level groups, which can reduce organizational costs and improve the feasibility of sustained participation.

Establishing a reusable survey and analysis workflow

The project established a complete workflow of standardized scale measurement, unified scoring, anonymization, robust regression, bootstrap path analysis, sensitivity verification, and multi-format output. The analysis code, statistical tables, and vector figures are all reproducible and reusable, providing a mature basis for subsequently expanding coverage, conducting periodic re-assessment, and comparing different villages.

Translation of findings into practice and recommendations***Establishing a “screening-assessment-referral-follow-up” mental health support loop***

This survey identified mental health support needs from two directions-negative symptoms and positive well-being-using the PHQ-9 and WHO-5, and generated priority review leads for the 29 respondents with non-zero responses on PHQ-9 item 9. The primary task of translating findings is to convert the risk signals in the questionnaire into a service process of “someone verifying, someone assessing, someone receiving, and someone revisiting”. China’s National Basic Public Health Service Standards have incorporated health management, health evaluation, and classified guidance for older adults into routine grassroots healthcare work. This policy framework provides a practical foundation to link survey findings with the daily practice of village doctors, family physicians, and township health centers. The project leader, together with village doctors or family doctors, should establish a priority watchlist, giving first attention to questionnaires with non-zero responses on PHQ-9 item 9, current status, and existing handling records; the list should be kept under minimum-necessary informed consent and encrypted storage.

Individuals identified by the PHQ-9 or WHO-5 as requiring support should receive face-to-face assessments. Practitioners stratify these participants according to several dimensions: duration of emotional distress, sleep and appetite status, social support, chronic conditions, and recent life events. This approach prevents reliance on a single score for clinical judgement.

For cases of mild or general psychological distress, practitioners may deliver listening support, health education, family communication guidance, and peer support. For participants with persistent distress, services should link individuals to family physicians for

professional psychiatric or psychological assessment. If acute risk is detected, teams must immediately activate professional medical response and accompaniment protocols.

Brief WHO-5 and PHQ-9 reassessments can be embedded within chronic disease follow-up, older adult health management, and volunteer services. Practitioners should record multiple indicators: review completion rates, referral completion rates, follow-up retention rates, and changes in psychological outcomes. This practice generates continuous service evidence.

Evaluations should attend not only to the number of people screened, but also to whether services actually reach people. Four key checkpoints are recommended: verification of priority leads within 24 hours, stratified assessment of screen-positive cases, post-referral feedback, and periodic reassessments. These checkpoints help convert survey data into clear, trackable records for grassroots mental health support.

Shifting from “increasing activity volume” to “safe, regular, companion-based, and less sedentary”

In this sample, 44 out of 55 (80.0%) reached the commonly used physical activity threshold, indicating that the focus of work should not simply be “more exercise” in general, but rather optimizing structure, ensuring safety, and reducing prolonged sitting on the basis of existing activity. WHO guidelines emphasize acting within one’s capacity and progressing gradually, and include muscle-strengthening, balance, and multicomponent activities in their recommendations for older adults. Activity promotion should also simultaneously address influencing factors such as individual function, family support, and environmental opportunities.

Prioritize low-threshold programs such as companion walking, tai chi, baduanjin, flexibility, and balance training, with warm-up, cool-down, and hydration segments. Those with a history of falls, marked activity limitation, or chronic disease symptoms should first be assessed by grassroots medical staff.

Reducing prolonged sedentary time should be treated as a standalone intervention target. During activities such as television viewing, card games, social chatting, appointment waiting, and village gatherings, rural older adults are encouraged to take 3-5 minutes of standing, slow walking or stretching every 30 to 60 minutes. Reminders can be delivered through village loudspeakers,

activity organizers, and family members.

Distinguish agricultural productive labor and household caregiving from purposeful healthy exercise. For those with heavy labor loads, emphasize recovery, stretching, joint protection, and balance training. For those with insufficient activity, increase activity gradually in short, frequent, accumulative sessions.

Set up basic, improvement, and priority-care groups according to physical function. Activity venues should give priority to lighting, non-slip surfaces, rest points, and emergency-contact conditions, while accommodating seasonal, farming-busy, and weather changes.

It is recommended to use participation rate, weekly activity frequency, number of sedentary interruptions, activity-related discomfort, fall events, and self-rated fitness changes as evaluation indicators. This makes it possible to observe both activity volume and organizational quality and safety benefits, shifting health promotion from “having held activities” to “forming routines and achieving improvement”.

Upgrading informal companionship into stable organizations

This survey found that most leisure-activity participants were mainly active together with family, friends, or neighbors, indicating that acquaintance networks already have a good mobilization base. Existing research shows that social relationships can affect health through emotional support, information exchange, behavioral norms, and mutual-aid resources. Therefore, when translating research findings into real-world practice, practitioners should foster spontaneous companion interactions and develop them into stable, inclusive, and sustainable village-based groups. In this way, physical activities can also serve as channels to strengthen social connectedness.

Activity groups of 5 to 10 participants can be formed within natural villages, villager groups or residential clusters. These groups follow broadly fixed schedules, designated contact persons, set meeting locations, and agreed safety rules. Meanwhile, flexibility is preserved to accommodate adjustments during busy farming periods and adverse weather.

An exercise-buddy system can be implemented. Within this system, older adults with consistent participation and strong communication skills act as group liaisons. They actively invite socially vulnerable peers - including those living alone, widowed older adults, people at risk of

social isolation, and individuals with activity limitations - to take part in adapted physical activities.

Organize brief exchanges before and after group sessions. These activities may include health knowledge sharing, birthday greetings, mutual support for chronic conditions, and volunteer assignments. Such arrangements help transform member relationships from merely “exercising together” toward daily care and tangible mutual support. Coordinate with village committees, senior associations, the Women’s Federation, village clinics, and returning university student volunteers to form a collaboration network for venue coordination, health guidance, personnel reminders, and emergency contact.

Organizational effectiveness can be judged comprehensively by group stability rate, sustained participation of new members, coverage of priority groups, LSNS-6 changes, and records of member mutual-aid events. For well-functioning groups, backbone members can be selected to form demonstration sites and expand to more villager groups through peer effects.

Consolidating and expanding survey outcomes

This project has already produced reusable outcomes including questionnaires, anonymized data, statistical scripts, three-line tables, and figures annotated in both Chinese and English. These research outcomes can be developed into a set of practical village-level tools, including needs assessment packages, interviewer training manuals, standardized health education content, and periodic evaluation instruments. Through coordinated efforts among grassroots departments, the study establishes a sustainable working cycle of “survey - feedback - service - re-test - re-optimization”. The Global Action Plan on Physical Activity emphasizes cross-sector collaboration, supportive environments, and continuous monitoring, which provides systematic thinking for the long-term translation of outcomes.

Optimize the electronic questionnaire logic by adding age-consistency checks, range checks for activity days and durations, total activity duration checks, missing-item alerts, and risk-item alerts. Retaining a unified variable dictionary and scoring rules to improve the comparability of subsequent re-tests. Routine training for interviewers should cover scale interpretation, privacy protection protocols, communication techniques, standardized psychological support procedures, and risk scenario drills.

This comprehensive training ensures seamless linkage across field investigation, on-site feedback, professional referral, and ongoing follow-up services.

Provide village committees and clinics with a concise village-level profile highlighting priority needs, available resources, and suggested indicators. When feeding back to older adults and their families, use easy-to-understand language and never display any individually identifiable information.

A periodic reassessment mechanism should be set up. It tracks ongoing changes in physical activity, sedentary behavior, social networks, WHO-5 scores, and PHQ-9 scores. The team also documents participation progress, service coverage, and typical cases. These materials support project reviews and future resource mobilization. Outcome evaluation should retain both “process indicators” and “health indicators”: The former reflects coverage, participation, referral, and organizational operation; the latter reflect changes in activity structure, social connectedness, and psychological state. Through unified definitions, periodic aggregation, and village-level feedback, survey outcomes can continuously serve grassroots decision-making and provide a basis for cross-village comparison and expansion of project coverage.

Validity of the survey and outcome evaluation

The sample included 60 rural older adults. It generated a multidimensional profile covering physical activity, sedentary behavior, social networks, depressive symptoms, well-being, and general health status. These data are adequate to inform needs assessment and intervention design for this “Three Going to the Countryside” initiative.

The Cronbach’s alpha values of LSNS-6, PHQ-9, and WHO-5 were 0.941, 0.954, and 0.963 respectively, indicating high internal consistency. The strong negative correlation between WHO-5 and PHQ-9 further verified the convergent direction of the mental health measurements. The analysis simultaneously used FDR correction, HC3 robust standard errors, 10,000 bootstrap replications, and multiple sensitivity schemes, with the main results directionally consistent overall, reflecting the rigor and stability of the statistical process.

The survey successfully identified four core service priorities: mental health support, sedentary time interruption, activity safety stratification, and companion-led group organization. Based on these

findings, the study developed a set of interconnected, practice-oriented recommendations for evidence translation and grassroots implementation. Anonymized data derived, statistical summary tables, reproducible code, and PNG/PDF/SVG figures were delivered in full, giving the results continuous applied value for review, presentation, reporting, and subsequent tracking. Scale results used for group screening and stratified services, combined with assessment by village doctors, family doctors, and professionals, can form standardized, prudent, and sustainable grassroots health support.

Conclusion

This survey reaches systematic conclusions about physical activity, social networks, and mental health among rural older adults. First, participants exhibit a favorable overall physical activity baseline, with 44 out of 55 (80.0%) meeting the standard physical activity threshold. However, the median daily sedentary time reached 422.5 minutes, indicating that sustaining regular physical activity and disrupting prolonged sedentary behavior should be promoted simultaneously. Second, LSNS-6 results reveal that most older adults possess basic social connectedness. Informal companionship provided by relatives, friends, and neighbors during daily leisure activities further verifies the high feasibility of implementing village-level companion-based activity programs. Third, the PHQ-9 and WHO-5 scales effectively capture distinct mental health support needs among participants. The two measures are strongly and negatively correlated and demonstrate satisfactory internal consistency, confirming the survey’s robust practical value in screening and identifying at-risk priority groups.

Path analysis confirms a significant indirect effect of physical activity on mental health mediated by social connectedness. Specifically, enhanced social network connections contributes to higher WHO-5 well-being scores and lower PHQ-9 depressive symptom levels among rural older adults. Combined with correlation analysis and sensitivity verification, it can be concluded that the mental health of rural older adults is interrelated with activity context, social companionship, physical function, and living conditions. Health promotion should adopt a multi-dimensional, coordinated approach rather than pursuing a single activity-volume indicator.

At the practical level, this survey has translated the data

findings into four clear conclusions: Psychological screening needs to connect into an assessment-referral-follow-up loop. Activity services should emphasize safety, regularity, companionship, and less sedentary time; informal companionship can be further organized into village-level activity groups. Unified questionnaires, anonymized data, analysis procedures, and re-test indicators can support the continued application of outcomes. These pathways can provide direct evidence for “Three Going to the Countryside” projects, grassroots older-adult health management, and village-level volunteer services.

Future surveys can build on the existing outcomes and expand in depth: Extending to different regions and different types of villages and adopting stratified or probability sampling to form a more representative profile of rural older adults. Setting multiple follow-up time points to continuously observe coordinated changes in physical activity, social networks and mental health. Combining accelerometers, pedometers, or activity logs to refine the measurement of activity intensity, timing, and sedentary interruption. Further distinguishing productive labor, household caregiving, transport activity, and leisure exercise, and applying longitudinal mediation and multilevel models to examine the roles of family, neighborhood, and village environments.

Future work can also involve in-depth interviews, focus groups, and participant observation to understand older adults’ real motivations for joining or continuing activities, family support, and local cultural factors. On this basis, conduct intervention evaluations of companion walking, balance training, sedentary interruption, and village-level mutual-aid groups, comparing the coverage, adherence, and health benefits of different organizational approaches. By combining quantitative tracking, qualitative interpretation, and practical intervention, an older-adult physical and mental health promotion model better suited to rural areas can gradually take shape.

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Conflicts of Interest

The authors declare no conflict of interest.

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