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Exercise Frequency and Subjective Well-Being Among Older Adults in China: Health-Related and Relational Pathways in Two National Surveys

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Research Article

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Abstract

Background

Exercise is associated with well-being in later life, but it remains unclear whether health-related and relational pathways are reproducible across different surveys. We examined associations between exercise frequency and subjective well-being among older adults in China, distinguishing perceived health from contact and trust.

Methods

We analysed adults aged 60 years or older in the 2023 Chinese General Social Survey (CGSS; N = 2108) and the 2022 China Family Panel Studies (CFPS; N = 4672). Subjective well-being was measured by happiness in the CGSS and life satisfaction in the CFPS. Self-rated health represented the health-related pathway; social-contact frequency and generalized trust in the CGSS and neighbor trust in the CFPS represented distinct relational pathways. Adjusted ordinary least-squares models, bootstrap indirect-association estimates, exploratory interactions, survey weighting, and additional sensitivity analyses were used.

Results

Exercise frequency was positively associated with subjective well-being in both primary analyses. Self-rated health showed a positive indirect association in both surveys and was the only proposed pathway reproduced across datasets. Relational findings were indicator-specific: social-contact frequency did not show a supported indirect association in the CGSS, generalized trust showed a small indirect association in the CGSS, and neighbor trust did not show an indirect association in the CFPS. A gender interaction appeared only in the CGSS, while age and residential-background interactions were not significant in either survey. In weighted analyses, the CGSS association remained statistically significant; the weighted CFPS estimate remained positive but was weaker statistically (b = 0.0123, p=.064).

Conclusions

More frequent exercise was associated with higher subjective well-being among older adults in two Chinese national surveys. The most reproducible indirect pattern involved self-rated health, whereas relational pathways depended on the indicator measured. These findings support distinguishing health-related from relational processes and caution against interpreting cross-sectional indirect associations as causal mechanisms.

Background

Population aging has intensified interest in modifiable behaviours associated with psychological well-being in later life. By the end of 2024, adults aged 60 years and older accounted for 22.0% of China's population and those aged 65 years and older accounted for 15.6% [1]. Regular leisure-time physical activity nevertheless remains far from universal among older Chinese adults [2]. Physical exercise is especially relevant because it combines a potentially health-supportive behaviour with opportunities for continued engagement in everyday life.

Recent research has examined specific psychological pathways linking physical activity with later-life well-being. A 2026 BMC Psychology study, for example, examined self-efficacy as an intermediate process between physical activity and subjective well-being in older adults [3], while another recent study examined perceived social support and physical and mental health in relation to exercise and subjective well-being [4]. Earlier panel evidence has also linked physical activity with quality of life over time [5]. These studies support the importance of exercise for psychological functioning, but they leave a more discriminating question unresolved: do health-related and relational pathways show comparable reproducibility when examined across independent national surveys and when relational life is operationalized in different ways?

One possibility is a health-related pathway. Physical exercise may be associated with how older adults perceive their health and their capacity to manage everyday activities, while perceived health is itself closely related to psychological well-being. Research has linked physical activity, health status, self-efficacy and quality of life in later adulthood [5, 6]. Self-rated health therefore provides an observable indicator through which the exercise–well-being association can be examined. It does not, however, directly measure objective physical functioning, fitness or a causal change in bodily capacity.

A second possibility concerns relational experience. Social and interpersonal factors associated with physical activity in older adulthood include social networks, support, interaction and broader social environments, but these constructs are not interchangeable [7]. Intervention evidence likewise suggests that physical activity does not produce uniformly positive effects across loneliness, social support and network outcomes [8]. A social-identity perspective further indicates that the psychological value of group-based activity may depend on meaningful identification and sustained group membership rather than co-presence alone [9]. These distinctions matter because social-contact frequency describes how often interaction occurs, generalized trust represents an orientation toward people in general, neighbor trust concerns confidence in a specific category of others, and network resources require information about actual ties, positions or support. Work on aging also shows that network quantity, relationship quality and network structure can have different associations with well-being and loneliness [10, 11].

This study uses the 2023 Chinese General Social Survey (CGSS) and the 2022 China Family Panel Studies (CFPS) to examine these distinctions among adults aged 60 years or older. Both surveys include exercise frequency, self-rated health and a measure of subjective well-being, but they operationalize relational experience differently. The CGSS measures social-contact frequency and generalized trust, whereas the CFPS measures trust in neighbours. The surveys are therefore not pooled. Instead, they are

used for patterned cross-survey replication: the central question is whether substantive directions and pathway structures recur when related constructs are measured differently.

Conceptual framework and hypotheses

Exercise frequency and subjective well-being

Subjective well-being is the primary psychological outcome in this study. It is represented by happiness in the CGSS and life satisfaction in the CFPS. These measures capture related evaluations of life but are not assumed to be psychometrically identical, and their raw coefficients are therefore not directly compared across surveys. Exercise frequency may be associated with subjective well-being through perceived health, affective experiences, confidence in managing everyday routines and opportunities for continued engagement. The present analysis focuses on two sets of observable intermediaries available in the surveys: self-rated health and relational indicators.

H1. *Higher exercise frequency is positively associated with subjective well-being among older adults.*

A health-related pathway through self-rated health

Self-rated health summarizes how individuals evaluate their own health status. Although it does not directly measure physical functioning, chronic-disease control or fitness, it is psychologically relevant because it reflects how people experience their health in everyday life. Among older adults, these evaluations can be related to the perceived ability to maintain routines and participate in valued activities. The empirical claim is therefore deliberately narrow: exercise frequency, self-rated health and subjective well-being may form a reproducible pattern of association.

H2. *Exercise frequency shows a positive indirect association with subjective well-being through self-rated health.*

Relational pathways through contact and trust

Relational life should not be treated as a single construct. Social-contact frequency measures interactional exposure. Exercise may create occasions for repeated encounters, particularly when activity occurs in shared spaces or recurring groups, but contact frequency does not indicate whether interactions are supportive, emotionally meaningful or embedded in durable relationships. Generalized trust concerns expectations about the trustworthiness of people in general, whereas neighbor trust concerns confidence in a specific category of others. Neither measure is equivalent to network size, tie strength, received support or group membership. Each pathway is therefore tested separately at the level at which it is measured.

H3a. *In the CGSS, exercise frequency shows a positive indirect association with subjective well-being through social-contact frequency.*

H3b. *In the CGSS, exercise frequency shows a positive indirect association with subjective well-being through generalized trust.*

H3c. *In the CFPS, exercise frequency shows a positive indirect association with subjective well-being through neighbor trust.*

The distinction between perceived health and social contact also permits a more complex test in the CGSS. Better perceived health may make participation in everyday social settings easier, and more frequent contact may in turn be associated with well-being. However, improved perceived health does not necessarily generate meaningful interaction, and contact itself does not establish supportive relationships.

H4. *In the CGSS, exercise frequency shows a positive sequential indirect association with subjective well-being through self-rated health and social-contact frequency.*

Patterned replication and exploratory contextual variation

The two datasets provide a patterned replication design rather than a pooled estimate. A pathway receives stronger empirical support when the same substantive pattern is observed despite differences in measurement. Conversely, a pathway that appears for one relational indicator but not another is not automatically a failed replication because generalized trust, neighbor trust and contact frequency are substantively different constructs.

RQ1. *Which associations between exercise frequency, subjective well-being, self-rated health and relational indicators are reproduced across the CGSS and CFPS, and which are specific to particular relational measures?*

Gender, age and residential context may also be associated with different exercise opportunities and social experiences. However, neither dataset directly measures exercise type, exercise location, companions or group membership. These characteristics are therefore treated as exploratory moderators rather than direct measures of the social organization of exercise.

RQ2. *Does the association between exercise frequency and subjective well-being vary by gender, age or residence/hukou status?*

The hypothesized direct, indirect, sequential, cross-survey and exploratory pathways are summarized in Fig. 1.

Methods

Study design and analytic samples

This study used individual-level data from the 2023 Chinese General Social Survey (CGSS) and the 2022 China Family Panel Studies (CFPS). Respondents were eligible if they were aged 60 years or older at the time of interview. The two surveys were analysed separately and were used for patterned cross-survey replication rather than coefficient pooling.

For the CGSS, the analytic sample included respondents with valid information on happiness, exercise frequency, self-rated health, social-contact frequency, generalized trust and all covariates, yielding 2108 complete cases. For the CFPS, valid information was required for life satisfaction, exercise frequency, self-rated health, neighbor trust and all covariates, yielding 4672 complete cases. Within each survey, the same complete-case sample was used for the baseline and indirect-association models so that changes across model specifications were not attributable to changes in the analytic sample. Exercise duration was available only for CFPS respondents who reported exercising, producing a supplementary analytic sample of 1841 respondents.

The surveys were not treated as interchangeable measurements of the same constructs. Their exercise-frequency scales differ, the CGSS assesses happiness whereas the CFPS assesses life satisfaction, and the available relational indicators are not identical. The income covariates also differ between surveys. Accordingly, raw regression coefficients were not interpreted as directly comparable effect sizes. Cross-survey comparison focused instead on whether the direction and structure of observed associations were reproduced under different operationalizations.

Measures

Exercise frequency

Exercise frequency was the focal explanatory variable. In the CGSS, item A3009 is originally coded from 1 for daily exercise to 5 for never and was reverse-coded so that higher scores represented more frequent exercise, ranging from 1 for never to 5 for daily exercise. In the CFPS, item QP701N contains categories 1–7 representing increasing exercise frequency and category 8 indicating never exercising; category 8 was recoded to 0 and categories 1–7 were retained. A binary sensitivity measure contrasted respondents exercising at least monthly with those exercising several times a year or never.

Subjective well-being

Subjective well-being was the primary outcome. In the CGSS it was measured using happiness (item A36), and in the CFPS it was measured using life satisfaction (item QN12012). Both outcomes used five-point scales with higher scores indicating higher subjective well-being. Happiness and life satisfaction were treated as related rather than identical indicators.

Self-rated health

Self-rated health was used to examine the health-related pathway. The CGSS measure (item A15) is coded so that higher values indicate better self-rated health. The CFPS measure (item QP201) originally ranges from 1 (very healthy) to 5 (unhealthy) and was reverse-coded as 6 minus the original response so that higher scores likewise indicated better perceived health. Self-rated health was not treated as a direct measure of objective physical functioning or embodied capital.

Relational indicators

The CGSS includes social-contact frequency (item A311; 1=never, 5=very frequently) and generalized social trust (item A33; 1–5). The CFPS includes trust in neighbours (item QN10022; 0–10). Social-contact frequency represents frequency of interaction, generalized trust reflects an orientation toward people in general, and neighbor trust concerns confidence in a specific category of others. None was interpreted as a direct measure of network size, tie strength, received support or group membership.

Covariates

Adjusted models included age, gender, education in years, marital status, residential context and logged income. Residential context was represented by hukou status in the CGSS and urban–rural residence in the CFPS. The CGSS income covariate is total household income, whereas the available CFPS measure is individual employment income. For the CFPS, non-employed respondents were coded as zero before applying ln(1+income). Because these measures represent different economic units, income coefficients were not compared directly between surveys. Supplementary Table S1 summarizes the measures and coding recoverable from the source manuscript.

Statistical analysis

Ordinary least-squares (OLS) regression estimated the conditional association between exercise frequency and subjective well-being separately in the CGSS and CFPS. All baseline models included the sociodemographic covariates described above and used HC1 heteroskedasticity-robust standard errors. Happiness and life satisfaction were treated as approximately continuous in the primary analyses to permit a common linear model structure across baseline and indirect-association analyses. Coefficients are interpreted as adjusted conditional mean differences in observed well-being scores, not as causal effects. The present analyses do not establish robustness to alternative ordinal-outcome estimators.

For pathway analyses, separate models first estimated the association between exercise frequency and each proposed intermediary (path a). Outcome models then estimated the association between each intermediary and subjective well-being while including exercise frequency, the available intermediaries within that survey and the covariates (path b). Indirect associations were calculated as the product of

the corresponding a and b coefficients, with confidence intervals obtained from 5000 non-parametric bootstrap replications. The CGSS additionally permitted assessment of the sequence exercise frequency → self-rated health → social-contact frequency → happiness. Because all focal variables were measured cross-sectionally, these quantities are described as indirect associations rather than identified causal mediation effects.

Cross-survey replication was assessed at the level of substantive patterns rather than raw coefficient equality. A pathway was considered more reproducible when the same directional pattern was observed across the CGSS and CFPS despite differences in measurement. Exploratory interaction models addressed RQ2 by testing exercise-by-gender, exercise-by-age-group (60–74 versus 75 years or older), and exercise-by-residential-context terms. Statistical significance within separate subgroups was not used as evidence of between-group difference.

Sensitivity analyses used survey weights, PSU-clustered standard errors in the CFPS, a binary participation measure, logged exercise duration among CFPS exercisers and propensity-score matching (PSM) in the CGSS. The PSM model included age, gender, education, household income, hukou and marital status; self-rated health was excluded because it was examined as a potential intermediate variable. Nearest-neighbour matching used a 0.05 caliper. PSM was used to assess sensitivity to observed sociodemographic composition and was not interpreted as quasi-experimental identification.

Reporting was guided by the STROBE recommendations for cross-sectional observational studies [12]. During manuscript preparation, ChatGPT (OpenAI) was used to assist with language editing and structural revision of manuscript text. It was not used to access, process or analyse participant-level CGSS or CFPS microdata. All AI-assisted text was reviewed and revised by the author, who takes full responsibility for the final content.

Results

Descriptive characteristics

Table 1 presents selected characteristics of the complete-case analytic samples. The CGSS analysis included 2108 adults aged 60 years or older, and the CFPS analysis included 4672. Mean exercise frequency was 2.52 (SD=1.74) in the CGSS and 2.18 (SD=2.83) in the CFPS. Mean happiness in the CGSS was 3.91 (SD=0.90), and mean life satisfaction in the CFPS was 4.23 (SD=0.87). Mean self-rated health was 2.98 (SD=1.12) in the CGSS and 2.65 (SD=1.26) in the CFPS after reverse coding. Because exercise, well-being and relational measures use different scales, raw means were not compared across surveys.

Table 1. Selected characteristics of the CGSS and CFPS analytic samples

Survey	Variable	N	Mean	SD	Range
CGSS 2023	Exercise frequency	2108	2.52	1.74	1–5
CGSS 2023	Happiness	2108	3.91	0.90	1–5
CGSS 2023	Self-rated health	2108	2.98	1.12	1–5
CGSS 2023	Social-contact frequency	2108	2.57	1.22	1–5
CGSS 2023	Generalized social trust	2108	3.59	1.03	1–5
CGSS 2023	Age	2108	69.86	6.79	60–94
CFPS 2022	Exercise frequency	4672	2.18	2.83	0–7
CFPS 2022	Life satisfaction	4672	4.23	0.87	1–5
CFPS 2022	Self-rated health (reversed)	4672	2.65	1.26	1–5
CFPS 2022	Neighbor trust	4672	7.02	2.23	0–10
CFPS 2022	Age	4672	68.43	6.05	60–97

Note. Higher self-rated-health scores indicate better perceived health in both surveys. Raw means are not compared across surveys because measurement scales differ.

Exercise frequency and subjective well-being

Exercise frequency was positively associated with subjective well-being in the primary adjusted models in both surveys (Table 2). In the CGSS, higher exercise frequency was associated with higher happiness scores (b=0.0673, SE=0.0116, p<.001). In the CFPS, exercise frequency was positively associated with life satisfaction (b=0.0170, SE=0.0045, p<.001). The corresponding standardized coefficients were 0.131 in the CGSS and 0.055 in the CFPS (Figure 2). Because the surveys differ in scales, samples and covariates, these coefficients were not interpreted as evidence that the association was substantively stronger in one survey. The positive direction of association was reproduced across the two primary complete-case analyses, supporting H1 at this stage of analysis.

Table 2. Associations between exercise frequency and subjective well-being

Model information	CGSS 2023	CFPS 2022
Dependent variable	Happiness (1–5)	Life satisfaction (1–5)
Exercise frequency	0.0673*** (0.0116)	0.0170*** (0.0045)
Sociodemographic controls	Yes	Yes
N	2108	4672
R^2	0.050	0.014

*Note. Values are unstandardized OLS coefficients with HC1 robust standard errors in parentheses. Models adjust for age, gender, education, marital status, residential context and logged income. *p<.10, **p<.05, ***p<.01.*

Points show standardized OLS coefficients and horizontal lines show 95% confidence intervals. Standardized coefficients were calculated as b×SD(X)/SD(Y) using the corresponding survey-specific exercise and well-being scales. The figure summarizes each survey separately and does not test equality of coefficients between the CGSS and CFPS.

Health-related and relational indirect associations

The self-rated-health pathway showed the same substantive pattern in both surveys (Table 3). In the CGSS, exercise frequency was positively associated with self-rated health (path a: b=0.0941, SE=0.0143, p<.01), and self-rated health was positively associated with happiness in the outcome model (path b: b=0.1422, SE=0.0182, p<.01). The indirect association was 0.0134 (95% bootstrap CI [0.0085, 0.0189]). In the CFPS, exercise frequency was positively associated with self-rated health (path a: b=0.0427, SE=0.0067, p<.01), and self-rated health was positively associated with life satisfaction (path b: b=0.1107, SE=0.0099, p<.01). The indirect association was 0.0047 (95% bootstrap CI [0.0031, 0.0065]). H2 was therefore supported in both datasets and represented the only proposed indirect pathway reproduced across surveys.

The relational results were indicator-specific. In the CGSS, exercise frequency was positively associated with social-contact frequency, but the indirect association through contact was 0.0018 (95% CI [−0.0003, 0.0043]); H3a was not supported. Generalized trust yielded an indirect association of 0.0049 (95% CI [0.0010, 0.0094]), supporting H3b, although the association was small. In the CFPS, exercise frequency was not associated with neighbor trust and the indirect association was −0.0004 (95% CI [−0.0025, 0.0018]); H3c was not supported.

Table 3. Health-related and relational indirect associations with subjective well-being

Survey	Indirect pathway	Path a, b (SE)	Path b, b (SE)	Indirect association	95% bootstrap CI
CGSS	Self-rated health	0.0941*** (0.0143)	0.1422*** (0.0182)	0.0134	[0.0085, 0.0189]
CGSS	Social-contact frequency	0.0656*** (0.0166)	0.0268* (0.0159)	0.0018	[−0.0003, 0.0043]
CGSS	Generalized trust	0.0345** (0.0139)	0.1418*** (0.0207)	0.0049	[0.0010, 0.0094]
CFPS	Self-rated health	0.0427*** (0.0067)	0.1107*** (0.0099)	0.0047	[0.0031, 0.0065]
CFPS	Neighbor trust	−0.0048 (0.0118)	0.0929*** (0.0063)	−0.0004	[−0.0025, 0.0018]

*Note. Path a represents the association between exercise frequency and the specified intermediary. Path b represents the association between the intermediary and subjective well-being in the corresponding outcome model. Indirect associations are products of the a and b coefficients; 95% CIs are based on 5000 non-parametric bootstrap replications. These estimates describe cross-sectional indirect associations and are not interpreted as causal mediation effects. *p<.10, **p<.05, ***p<.01.*

Sequential indirect association and patterned replication

In the CGSS sequential model, self-rated health was positively associated with social-contact frequency (b=0.0884, p<.001), but the exercise frequency → self-rated health → social-contact frequency → happiness indirect association was 0.00022 (95% bootstrap CI [−0.00004, 0.00059]). H4 was therefore not supported. In the full CGSS model, the remaining exercise coefficient was 0.0472 (SE=0.0115, p<.001), and the three estimated indirect associations together represented approximately 29.8% of the observed total association. In the CFPS, the corresponding exercise coefficient was 0.0128 (SE=0.0043, p=.003), and the self-rated-health indirect association represented approximately 27.8% of the observed total association. These proportions describe decomposition of observed cross-sectional associations and are not interpreted as proportions of a causal effect.

Addressing RQ1, the clearest convergence concerned self-rated health: the corresponding bootstrap indirect intervals excluded zero in both datasets. Relational results did not show the same pattern. Social-contact frequency did not yield a non-zero indirect association in the CGSS, generalized trust did, and neighbor trust did not in the CFPS. The cross-survey pattern was therefore more consistent for self-rated health than for the relational indicators, which were indicator-specific rather than evidence of a single replicated relational pathway.

Exploratory conditional variation

Exploratory interaction models addressed RQ2 (Table 4). In the CGSS, the estimated exercise coefficient was 0.0445 for women and 0.0908 for men, with an exercise-by-gender interaction of 0.0462 (p=.033). In the CFPS, the corresponding coefficients were 0.0143 for women and 0.0195 for men, and the interaction was not statistically significant (interaction=0.0053, p=.541). The gender difference observed in the CGSS was therefore not reproduced in the CFPS. Age interactions were non-significant in both surveys, as were the CGSS hukou and CFPS urban–rural interactions. Taken together, the exploratory analyses provided little evidence of reproducible conditional variation by gender, age or residential context.

Table 4. Exploratory interactions in the exercise–well-being association

Survey	Moderator	Reference-group exercise coefficient	Comparison-group exercise coefficient	Interaction coefficient	p
CGSS	Hukou	Non-agricultural: 0.0522***	Agricultural: 0.0827***	0.0305	.180
CGSS	Gender	Women: 0.0445***	Men: 0.0908***	0.0462	.033
CGSS	Age	60–74: 0.0728***	≥75: 0.0504**	−0.0223	.377
CFPS	Residence	Rural: 0.0222***	Urban: 0.0130**	−0.0092	.308
CFPS	Gender	Women: 0.0143**	Men: 0.0195***	0.0053	.541
CFPS	Age	60–74: 0.0184***	≥75: 0.0110	−0.0074	.491

*Note. Interaction coefficients represent the difference in the exercise coefficient for the comparison group relative to the reference group. These analyses address RQ2 and are exploratory. Statistical significance within one subgroup is not evidence of a between-group difference. *p<.10, **p<.05, ***p<.01.*

Sensitivity analyses

Sensitivity analyses qualified the strength of the primary findings (Table 5). The survey-weighted CGSS estimate remained positive and statistically significant (b=0.0803, SE=0.0127, p<.001; N=2108). In the CFPS model using the individual cross-sectional weight and PSU-clustered standard errors, the estimate remained positive but was weaker statistically (b=0.0123, SE=0.0066, p=.064; N=4492). Binary exercise participation remained positively associated with well-being in both datasets. Among 1841 CFPS respondents with exercise-duration data, ln(1+exercise minutes) was not associated with life satisfaction (b=0.0053, SE=0.0327, p=.872).

In the CGSS matching analysis, 865 respondents exercising at least monthly formed the exposed group and 1243 respondents exercising several times a year or never formed the comparison group. Nearest-neighbour matching within a 0.05 caliper matched 863 exposed respondents, and all post-match absolute standardized mean differences were below 10%. The software-labelled ATT was 0.1808 (SE=0.0387, p<.001; 863 matched pairs). This result shows that the positive association persisted after

balancing the observed sociodemographic covariates included in the propensity model. It does not establish a causal treatment effect or resolve unmeasured confounding or temporal ordering.

Table 5. Sensitivity analyses of the exercise–well-being association

Sensitivity analysis	Survey/sample	Exposure or specification	Estimate (SE)	p	N
Survey weighting	CGSS	Continuous exercise frequency	0.0803 (0.0127)	<.001	2108
Weighting + PSU clustering	CFPS	Continuous exercise frequency	0.0123 (0.0066)	.064	4492
Binary participation	CGSS	At least monthly	0.2008 (0.0406)	<.001	2108
Binary participation	CFPS	At least monthly	0.0837 (0.0262)	.001	4672
Alternative exposure	CFPS exercisers	ln(1+minutes)	0.0053 (0.0327)	.872	1841
PSM	CGSS matched sample	Matched mean difference (software-labelled ATT)	0.1808 (0.0387)	<.001	863 pairs

Note. The weighted CGSS model uses weight1. The CFPS model uses rswt_natcs22n with PSU-clustered standard errors. ATT is retained as the statistical label of the matching estimand and is not interpreted here as a causal treatment effect.

Discussion

Principal findings

This study examined whether exercise frequency was associated with subjective well-being among older adults and whether health-related and relational indirect associations showed similar patterns across two national surveys in China. Three findings stand out. First, higher exercise frequency was positively associated with subjective well-being in the primary adjusted analyses in both the CGSS and CFPS. Second, self-rated health showed the most consistent indirect pattern across the two surveys. Third, the relational findings were substantially less uniform: social-contact frequency did not show a supported indirect association in the CGSS, generalized trust showed a small indirect association in the CGSS, and neighbor trust did not form an indirect pathway in the CFPS.

The two surveys therefore converged most clearly on the health-related pathway rather than on a generalized relational pathway. This convergence should not be interpreted as evidence that self-rated health is the causal mechanism linking exercise to well-being. The data are cross-sectional, and the observed indirect associations cannot establish temporal ordering. The more defensible conclusion is

that perceived health occupies a more reproducible position in the observed exercise–well-being association than the relational indicators measured in these surveys.

Why self-rated health showed the most reproducible pattern

The repeated self-rated-health pattern is psychologically meaningful because self-rated health reflects how individuals evaluate their own health in everyday life. Among older adults, such evaluations may be connected with perceived ability to maintain routines, manage daily demands and remain engaged in valued activities. Previous work has similarly linked physical activity, health status and quality of life in later adulthood [6, 13]. An embodied-capacity perspective provides a secondary interpretation of this pattern: later-life well-being may depend partly on whether individuals experience their bodies as enabling rather than restricting everyday action. The contribution of the present findings is not to establish embodied capital as a measured mechanism. Self-rated health does not directly assess functional capacity, fitness, chronic-disease control or embodied dispositions, and healthier older adults may also be more able or more willing to exercise.

The cross-survey repetition is therefore important at a narrower level. Despite differences in exercise scales and well-being outcomes, self-rated health occupied the same intermediate position in both datasets. This makes the health-related pattern more reproducible than the relational patterns examined here while leaving open the direction and causal ordering of the underlying relationships.

Why the relational indicators diverged

The relational results show why contact and trust should not be treated as interchangeable indicators of a single social process. In the CGSS, exercise frequency was positively associated with social-contact frequency, but the indirect interval through contact included zero. More frequent interaction therefore did not, in these data, translate into a supported indirect association with happiness. This distinction is consistent with the idea that opportunities for interaction are not equivalent to psychologically meaningful relationships. Experimental evidence also shows that increases in physical fitness need not be accompanied by corresponding changes in broader psychosocial functioning [14].

Generalized trust showed a different pattern. In the CGSS it carried a small indirect association between exercise frequency and happiness, whereas in the CFPS neighbor trust was positively associated with life satisfaction but was not associated with exercise frequency. These findings do not establish that exercise produces greater trust. Generalized trust and neighbor trust concern different social objects, and their relationship with exercise may reflect dispositions or contextual characteristics not observed in the surveys.

The combined evidence therefore does not support either a uniformly positive or a uniformly absent relational pathway. Research on group-based activity indicates that psychological and social benefits can depend on sustained membership and identification rather than co-presence alone [15, 16], while

longitudinal work on retirement similarly highlights the importance of social group continuity and gain for later-life well-being [17]. Group-based physical activity may reduce isolation or loneliness under some conditions, but those conditions are not captured by simple contact counts or trust measures [18].

What patterned cross-survey replication adds

The use of two surveys provides information that would be difficult to obtain from a single dataset. The purpose was not to compare numerical coefficient size because exercise frequency, subjective well-being, relational indicators and several covariates are operationalized differently. Rather, the comparison asked which substantive patterns reappeared despite those differences. On this criterion, self-rated health showed the clearest replication and the relational indicators did not. This contrast is informative because treating all positive associations with contact or trust as evidence for a generic social pathway would obscure the distinction between a reproducible health-related pattern and indicator-specific relational findings.

The divergence across relational measures should therefore not be interpreted simply as replication failure. It indicates that conclusions about the relational correlates of exercise are sensitive to the construct being measured. The same caution applies to subjective well-being: happiness and life satisfaction fall within the broader domain of subjective well-being, but they are not identical outcomes. The present study therefore supports replication at the level of substantive direction and pathway structure rather than equivalence of effect size or measurement.

Exploratory conditional variation

The interaction analyses provided little evidence that the exercise–well-being association varied consistently across the demographic groups examined. The gender interaction observed in the CGSS was not reproduced in the CFPS, while age and residential-context interactions were not statistically supported in either dataset. These findings argue against constructing a strong subgroup explanation from the present data. In particular, the significant CGSS gender interaction alone is insufficient to conclude that exercise is more strongly associated with well-being among men.

Residential categories also require caution. Hukou status and urban–rural residence do not directly measure exercise environments, facility access, activity type, companions or group membership. Direct measures of where, how and with whom older adults exercise are needed before contextual interpretations can be evaluated.

Psychological implications

The findings suggest that the psychological significance of exercise in later life should not be reduced either to physical health alone or to an assumed expansion of social relationships. The most consistent observed pathway involved self-rated health, while the relational indicators showed more selective patterns. This supports a differentiated account in which exercise can be associated with well-being through multiple domains without requiring every domain to operate in the same way.

The measured indirect associations also leave a substantial proportion of the exercise–well-being association unexplained. Potential psychological processes could include self-efficacy, affective regulation, daily structure, perceived competence or group identity, but none of these constructs was directly measured in the present analyses. Their possible relevance should therefore guide future measurement rather than be treated as explanations established by the current results. At a broader social-psychological level, exercise settings may provide opportunities for maintaining routines or encountering others after later-life roles and relationships have changed. The present surveys do not directly measure belonging, group identification, reciprocal support or actual network expansion, so social re-embedding is best treated as a possible interpretive context for future work rather than an outcome demonstrated here.

Limitations and future research

Several limitations define the boundaries of these findings. First, the cross-sectional design prevents establishment of temporal ordering. More frequent exercise may be associated with better perceived health and higher well-being, but better health or higher well-being may also make regular exercise easier to initiate or sustain. Bootstrap indirect associations therefore cannot be interpreted as causal mediation effects. Second, propensity-score matching balances only observed covariates and does not remove health selection, personality, community resources, prior well-being or other unmeasured confounding.

Third, population-level sensitivity evidence was not equally strong across surveys. The weighted CGSS estimate remained statistically significant, whereas the weighted CFPS estimate with PSU-clustered standard errors remained positive but was weaker statistically ($b = 0.0123$, $p=.064$). The common positive direction across primary models is informative, but the findings should not be described as equally robust to survey weighting in both datasets. Fourth, self-rated health is a broad perceived-health indicator rather than a direct measure of objective physical functioning. Future work could combine subjective health with activities of daily living, instrumental activities of daily living or physical-performance measures.

Fifth, the relational indicators are necessarily limited. Social-contact frequency does not measure interaction quality, network size, tie strength or received support. Generalized trust and neighbor trust concern different social objects and are not interchangeable. Future studies should directly assess exercise companions, group membership, social identification, relationship continuity, perceived support and network structure. Sixth, happiness and life satisfaction are related but distinct indicators of subjective well-being, exercise frequency is operationalized differently, and the income measures refer to different economic units. In particular, CFPS individual employment income is an imperfect representation of broader economic resources among older adults outside employment. Finally, the present analyses do not establish why exercise frequency showed positive associations when exercise duration among CFPS exercisers did not. Longitudinal studies with repeated measures of exercise behaviour, context, perceived health, psychological resources and relational experiences are needed to determine temporal sequencing and test more specific mechanisms.

Conclusions

Exercise frequency was positively associated with subjective well-being among older adults in two Chinese national surveys, but the observed association did not follow a single uniform pathway. Self-rated health showed the most reproducible indirect pattern across the CGSS and CFPS. Relational findings were more selective: generalized trust showed a small indirect association in the CGSS, whereas social-contact frequency and neighbor trust did not show supported indirect associations, and the CGSS health-to-contact sequential pathway was unsupported.

These findings support distinguishing perceived-health pathways from distinct relational processes and treating cross-survey convergence and divergence as substantive information rather than forcing heterogeneous relational measures into a single social mechanism. Because the evidence is cross-sectional, the findings identify reproducible patterns of association rather than causal mechanisms. Future research should combine longitudinal designs with direct measures of exercise context, group membership, social identification and physical functioning to clarify when regular exercise is linked to psychological well-being in later life.

Abbreviations

CGSS: Chinese General Social Survey

CFPS: China Family Panel Studies

OLS: Ordinary least squares

PSM: Propensity-score matching

PSU: Primary sampling unit

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

Declarations

Ethics approval and consent to participate

This study involved secondary analyses of de-identified data from the 2023 Chinese General Social Survey (CGSS) and the 2022 China Family Panel Studies (CFPS). The author did not recruit participants, conduct interviews or have direct contact with respondents. The CFPS is conducted by the Institute of Social Science Survey, Peking University. The CFPS project undergoes ethical review by the Peking University Biomedical Institutional Review Board (approval number IRB00001052-14010), and informed consent is obtained before each survey wave; respondents aged 15 years or older provide consent themselves [21]. All CFPS respondents included in this study were aged 60 years or older. The CGSS 2023 public-use data were collected and released by the National Survey Research Center at Renmin

University of China [19]. Ethical-review, informed-consent and participant-protection procedures for the original CGSS data collection were the responsibility of the original survey project. The present study used de-identified public-use data and involved no new participant contact. No additional participants were recruited and no new informed consent was obtained for the present secondary analyses. The present secondary analysis was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable institutional and national ethical guidelines.

Consent for publication

Not applicable. The manuscript contains no identifiable individual participant information, images, videos or case material.

Availability of data and materials

The datasets analysed in this study were obtained from the original survey providers. The 2023 CGSS was released by the National Survey Research Center at Renmin University of China [19] and is available to registered users through the Chinese National Survey Data Archive (CNSDA): https://www.cnsda.org. The official CGSS 2023 release notice is available at https://nsrc.ruc.edu.cn/xwdt/394403ac948c4916a48e80c3df55c6d6.htm. The 2022 CFPS public-use data are available to registered and approved users through the official CFPS Data Center: https://cfpsdata.pku.edu.cn/#/home; an alternative access point is the Peking University Open Research Data Platform: https://opendata.pku.edu.cn/dataverse/CFPS [20]. Under the CFPS Data User Agreement, CFPS microdata may not be redistributed through journal websites or unauthorized third-party platforms [22]. The CFPS microdata used in this study are therefore not deposited as supplementary material with this article. Researchers wishing to reproduce the analyses should obtain the relevant data directly from the official providers and comply with the applicable data-use agreements. No new primary dataset was generated by the author for this study.

Competing interests

The author declares no competing interests.

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Authors' contributions

YZ conceived the study, developed the conceptual framework, conducted the secondary-data analyses, interpreted the findings, and drafted and revised the manuscript. The author read and approved the final manuscript.

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Figures

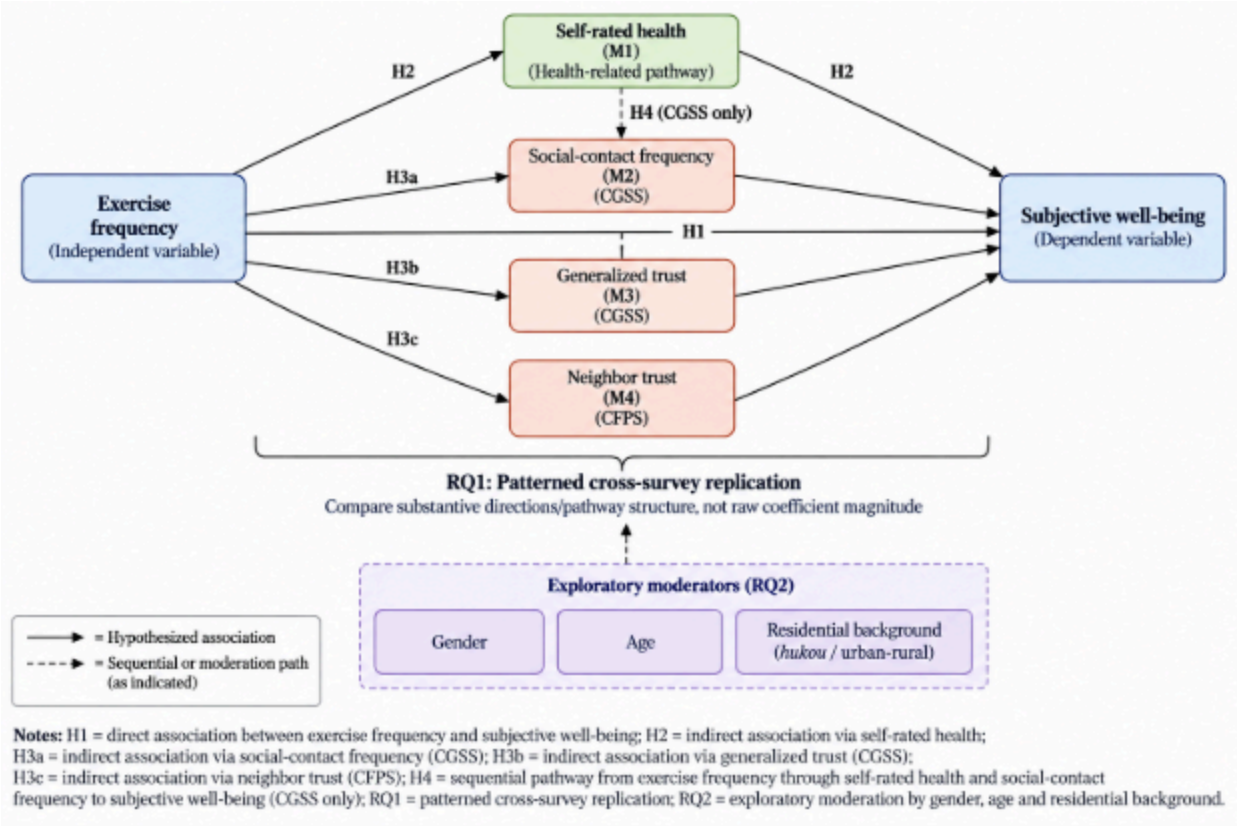


Figure 1

Conceptual framework for exercise frequency and subjective well-being in later life

Solid arrows indicate hypothesized associations. H2 and H3a–H3c represent indirect pathways through self-rated health and distinct relational indicators. H4 represents the CGSS-specific sequential pathway from exercise frequency through self-rated health and social-contact frequency to subjective well-being. RQ1 concerns patterned cross-survey replication of substantive directions and pathway structures, not equality of raw coefficients. RQ2 concerns exploratory moderation by gender, age and residential background. CGSS, Chinese General Social Survey; CFPS, China Family Panel Studies.

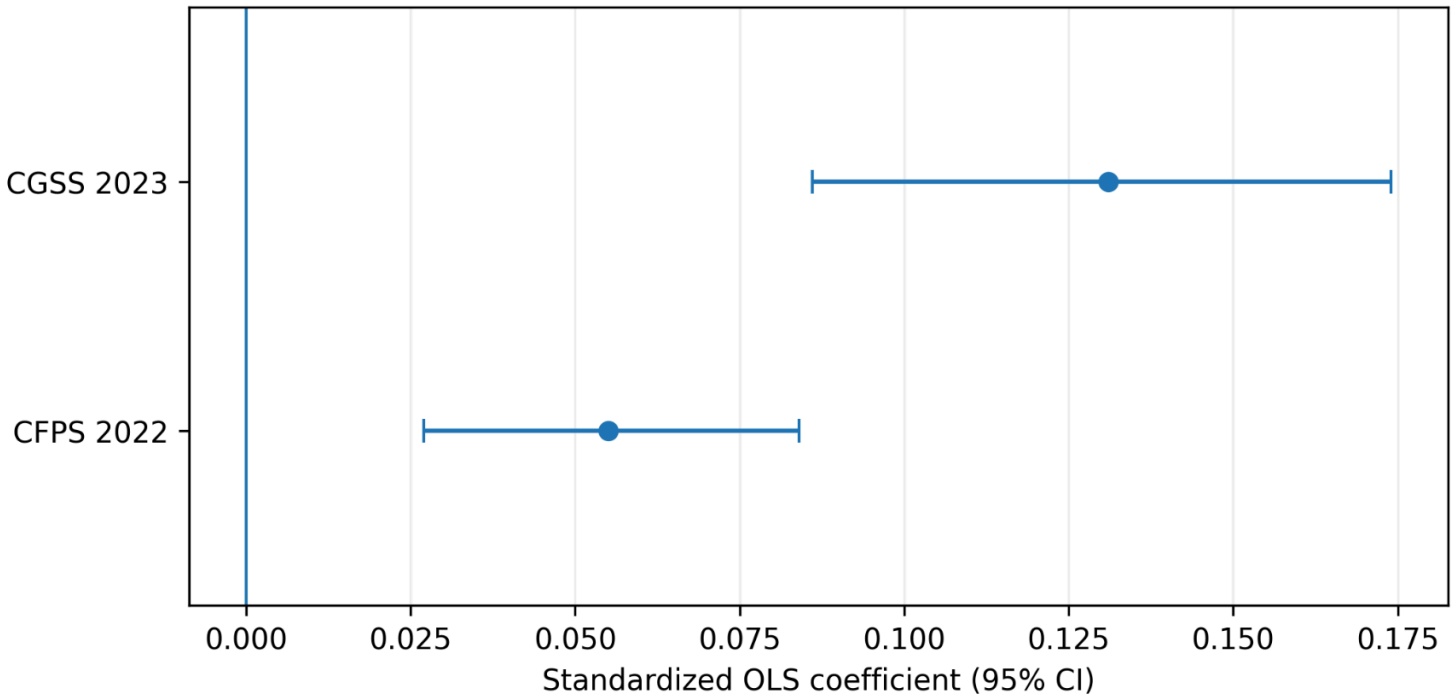


Figure 2

Standardized exercise–well-being associations in the two surveys

Points show standardized OLS coefficients and horizontal lines show 95% confidence intervals. Standardized coefficients were calculated as b×SD(X)/SD(Y) using the corresponding survey-specific exercise and well-being scales. The figure summarizes each survey separately and does not test equality of coefficients between the CGSS and CFPS.

Supplementary Files

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