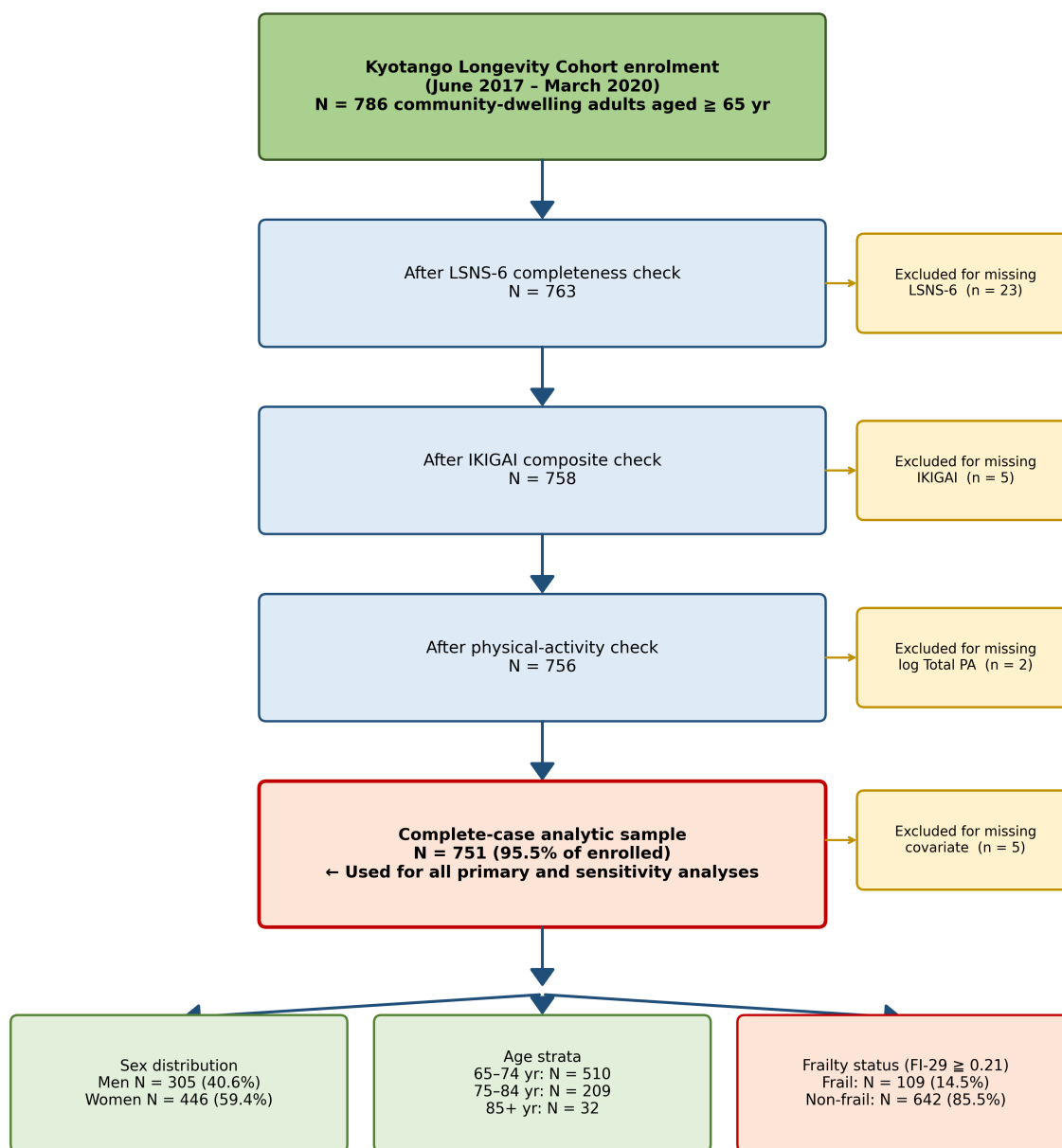
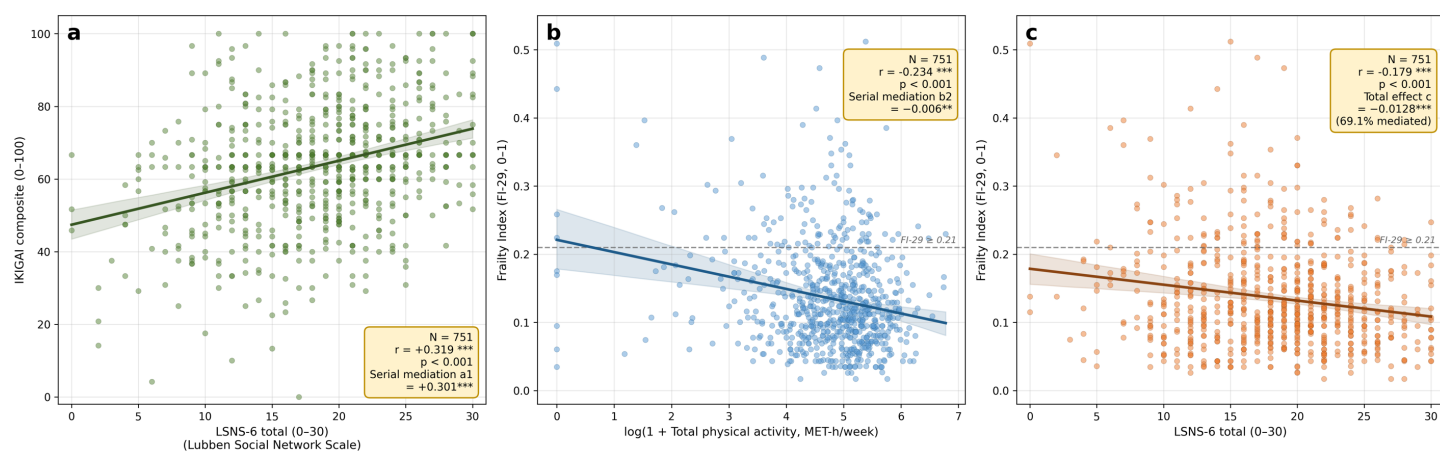


Supplementary Figure S1



*All exclusions due to item-level missingness in pre-specified primary variables.
No participants were excluded for any other reason. Item-level missingness was < 5% across all variables.*

Supplementary Figure S2



Supplementary Table S1. Pearson correlations among primary and secondary variables ($n = 751$)

Variable pair	Pearson r	Interpretation
LSNS-6 total — IKIGAI composite	+0.319 ***	Moderate positive (as hypothesised, a1 pathway)
IKIGAI composite — FI-29	-0.414 ***	Strongest inverse correlation (main driver)
IKIGAI composite — log(Total PA)	+0.056 ns	Nearly independent (serial chain rejected)
log(Total PA) — FI-29	-0.234 ***	Independent PA protective pathway (b2)
LSNS-6 total — FI-29	-0.179 ***	Direct-effect gradient (mostly IKIGAI-mediated)
WHO-5 — Life satisfaction	+0.539 ***	Convergent components of IKIGAI composite
Sport PA — Occupational PA	+0.064 ns	Independent PA domains
FI-32 — FI-29 / FI-26 / FI-23	+0.987 / +0.945 / +0.872 ***	Four FI versions highly correlated

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns $p \geq 0.05$. Full 13×13 matrix available on request.

Supplementary Table S2. Sensitivity to covariate adjustment level

Model	ind1 (LSNS→IKIGAI→FI)	Total indirect	% mediated
Unadjusted	-0.01038 [-0.01355, -0.00752]	-0.01113 [-0.01446, -0.00819]	64.9%
Minimal (Age, Sex, BMI, Chronic disease)	-0.00940 [-0.01228, -0.00683]	-0.00992 [-0.01294, -0.00716]	67.7%
Without dietary fibre (8 covariates)	-0.00852 [-0.01114, -0.00614]	-0.00895 [-0.01181, -0.00639]	68.6%
★ Main model (9 covariates)	-0.00845 [-0.01101, -0.00610]	-0.00887 [-0.01170, -0.00636]	69.1%

Main model (starred) = age, sex, BMI, education, smoking, drinking, chronic-disease count, energy intake, dietary fibre. Adjustment for fibre (the key exposure of the parallel diet–microbiota pathway in our companion paper) changes ind1 by <1% (from -0.00852 to -0.00845), demonstrating statistical independence from the diet–microbiota pathway.

Supplementary Table S3. Sex-stratified serial mediation (FI-29 outcome)

Coefficient / pathway	Male (<i>n</i> = 305)	Female (<i>n</i> = 446)
a1 (LSNS → IKIGAI)	+0.318*** (p<0.001)	+0.289*** (p<0.001)
b1 (IKIGAI → FI)	−0.031*** (p<0.001)	−0.027*** (p<0.001)
b2 (PA → FI)	−0.006 (p=0.024)	−0.007** (p=0.003)
c' (direct effect)	−0.001 (p=0.768)	−0.005 (p=0.040)
ind1 (LSNS→IKIGAI→FI)	−0.00988 [−0.01413, −0.00622]	−0.00768 [−0.01076, −0.00510]
ind2 (LSNS→PA→FI)	−0.00044 [−0.00171, +0.00027]	−0.00038 [−0.00139, +0.00010]
ind3 (Serial 3-step)	−0.00010 [−0.00046, +0.00018]	−0.00003 [−0.00020, +0.00009]
Total indirect	−0.01042 [−0.01481, −0.00668]	−0.00809 [−0.01127, −0.00554]
% mediated	79.3%	62.7%

Adjusted for 8 covariates (age, BMI, education, smoking, drinking, chronic-disease count, energy intake, dietary fibre; sex removed). Bootstrap percentile 95% CI from 2,000 resamples. This sex-modulation pattern is discussed as a substantive finding in Discussion and generates a falsifiable hypothesis for independent replication (see Kashiwa cohort comparison, ref 13).

Supplementary Table S4. Age-stratified serial mediation (FI-29 outcome)

Coefficient / pathway	65–74 yr (<i>n</i> = 510)	75–84 yr (<i>n</i> = 209)	85+ yr (<i>n</i> = 32)
a1 (LSNS → IKIGAI)	+0.275***	+0.358***	+0.402**
b1 (IKIGAI → FI)	−0.023***	−0.031***	−0.055**
ind1 (LSNS→IKIGAI→FI)	−0.00622 [−0.00832, −0.00425]	−0.01106 [−0.01666, −0.00614]	−0.02213 [−0.03840, −0.00853]
ind3 (Serial 3-step)	−0.00004 [−0.00021, +0.00011]	−0.00011 [−0.00067, +0.00027]	−0.00030 [−0.00195, +0.00104]
Total indirect	−0.00667 [−0.00892, −0.00457]	−0.01177 [−0.01750, −0.00666]	−0.02325 [−0.03975, −0.00928]
% mediated	77.1%	83.2%	62.1%

Adjusted for 8 covariates (age removed). 85+ yr *n* = 32 is small; interpret cautiously.

Supplementary Table S5. IKIGAI operationalisation sensitivity

Coefficient / pathway	Composite (continuous 0–100)	Single-item binary (Yes/No)
<i>n</i>	751	751
a1 (LSNS → IKIGAI)	+0.301 (p<0.001)	+0.204 (p<0.001)
b1 (IKIGAI → FI)	−0.028 (p<0.001)	−0.011 (p<0.001)
ind1 (LSNS→IKIGAI→FI)	−0.00845 [−0.01101, −0.00610]	−0.00224 [−0.00349, −0.00121]
ind3 (Serial 3-step)	−0.00005 [−0.00023, +0.00008]	−0.00002 [−0.00010, +0.00003]
Total indirect	−0.00887 [−0.01170, −0.00636]	−0.00264 [−0.00399, −0.00150]
% mediated	69.1%	21.3%

Composite = mean of WHO-5 percentage and life-satisfaction percentage. Binary = Sone 2008-style single-item ikigai measure (as used in Ohsaki, JAGES, and Kashiwa cohorts). Attenuation of magnitude in the binary version reflects information loss from dichotomisation.