Frailty Assessment in Older Adults: A Twenty-Four Month Cohort Across Three Frailty Strata: Phenotype Distribution, Outcomes, and Intervention Response in Three Hundred and Eighty-Two Adults Aged Sixty-Five and Older

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Abstract—**Frailty defined by the Fried phenotype as the presence of three or more of weight loss, exhaustion, weakness, slow gait, and low physical activity is a clinically distinctive state of increased vulnerability to adverse outcomes in older adults. Pre-frailty (one or two criteria) represents an intermediate stage with elevated risk and substantial intervention responsiveness. We undertook a 24-month prospective cohort study of 382 community-dwelling adults aged 65 and older. Frailty distribution showed 30.9% robust, 44.0% pre-frail, and 25.1% frail. All-cause mortality differed substantially by frailty class: 24-month mortality was 5% in robust, 12% in pre-frail, and 30% in frail patients (HR for frail vs robust 5.18). Similar gradients applied for hospitalisation (4.4-fold), recurrent falls (4.8-fold), ADL functional decline (6.4-fold), and institutionalisation (4.2-fold). Multicomponent intervention including resistance exercise, protein supplementation, vitamin D, polypharmacy review, and psychosocial support produced measurable benefits with approximately 30% of pre-frail patients reverting to robust status and 22% of frail patients improving to pre-frail. The findings support routine frailty assessment in primary care and integrated multicomponent intervention for pre-frail and frail older adults.**

Index Terms—**frailty, Fried phenotype, older adults, sarcopenia, comprehensive geriatric assessment, mortality, functional decline**

I. Introduction

Frailty has emerged as one of the most clinically useful concepts in geriatric medicine over the past two decades. The Fried phenotype defined by the presence of three or more of weight loss, exhaustion, weakness (grip strength), slow gait speed, and low physical activity operationalised frailty as a measurable clinical state. The complementary Rockwood frailty index approaches the phenomenon through cumulative deficits. Both approaches identify older adults at substantially elevated risk of adverse outcomes including mortality, hospitalisation, falls, functional decline, and institutionalisation (Jha, Kumar,, & Neha, 2026; Yatish, Khatoon,, & Kumar, 2026; Kumar, Sharma,, & Gupta, 2026). Pre-frailty represents an intermediate stage with elevated risk relative to robust counterparts and substantial responsiveness to intervention. Multi-component interventions including resistance exercise, protein and vitamin D supplementation, polypharmacy review, fall prevention, and psychosocial support have shown effect across trials. Implementation in real-

world settings particularly in South Asian healthcare contexts where frailty assessment is not routinely integrated into primary care remains a major operational challenge (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026). The South Asian context presents distinctive frailty patterns. Earlier onset of chronic disease (diabetes, cardiovascular disease) drives higher frailty prevalence at younger ages than Western populations. Multi-generational household structures provide informal caregiver support but also delay institutional care decisions. Polypharmacy is increasingly common as chronic disease management intensifies. We undertook a 24-month prospective cohort study of 382 community-dwelling adults aged 65 and older to characterise frailty distribution, document 24-month outcomes across frailty classes, evaluate multicomponent intervention response, and identify protective factors (Kumar, Sharma,, & Gupta, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Ashifa, 2022; Rasi, & Ashifa, 2019).

II. Methods

We conducted a 24-month prospective cohort study at an integrated geriatric medicine and primary care service between January 2023 and December 2024. Inclusion required (a) age 65 years or older at recruitment; (b) community-dwelling status (not residing in long-term care); (c) capacity to complete structured geriatric assessment; (d) consent for 24-month follow-up. Exclusion criteria included severe cognitive impairment limiting reliable engagement, advanced terminal illness with estimated prognosis <6 months, and inability to attend follow-up visits. The final cohort comprised 382 older adults .Frailty was assessed using the Fried phenotype criteria adapted to local context: (a) weight loss ≥4.5 kg or ≥5% body weight in the previous year; (b) exhaustion measured by the Center for Epidemiologic Studies Depression Scale items; (c) weakness measured by grip strength using a Jamar dynamometer with sex- and BMI-adjusted thresholds; (d) slow gait speed measured over 4 metres with sex- and height-adjusted thresholds; (e) low physical activity by Minnesota Leisure Time Activity Questionnaire below sex-specific thresholds. Classification used standard cut-points: robust (0 criteria), pre-frail (1-2 criteria), and frail (3-5 criteria). Comprehensive geriatric assessment additionally captured cognitive function (MoCA), nutritional status (MNA), comprehensive drug review, comorbidity burden, and social context. All pre-frail and frail participants received a structured multicomponent

intervention package: (a) supervised progressive resistance exercise (twice weekly for 12 weeks then maintenance); (b) protein supplementation targeting 1.2–1.5 g/kg/day with high-quality protein sources; (c) vitamin D supplementation 800–2000 IU daily based on baseline levels; (d) structured polypharmacy review using STOPP/START criteria with deprescribing where appropriate; (e) psychosocial support including social engagement, depression screening, and caregiver support; (f) home safety assessment and fall prevention. Robust participants received lifestyle reinforcement and annual reassessment.

2.1 Outcomes and Analysis

Primary outcomes were all-cause mortality and a composite adverse outcome (mortality, any hospitalisation, recurrent falls, ADL functional decline, or institutionalisation) over 24 months. Secondary outcomes included frailty class transitions (improvement, worsening, stability), specific functional outcomes (gait speed, grip strength, SPPB score), quality of life (EQ-5D-5L), polypharmacy reduction, and caregiver burden. Kaplan-Meier estimation generated survival curves; multivariable Cox regression identified independent predictors of adverse outcomes.

III. Results

3.1 Frailty Distribution

Baseline frailty distribution is shown in Figure 1. Robust participants accounted for 30.9% of the cohort, pre-frail for 44.0%, and frail for 25.1%. The substantial pre-frail proportion (n=168) highlights the population at greatest intervention opportunity — these individuals have measurable vulnerability but substantial responsiveness to structured intervention before progression to frank frailty (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

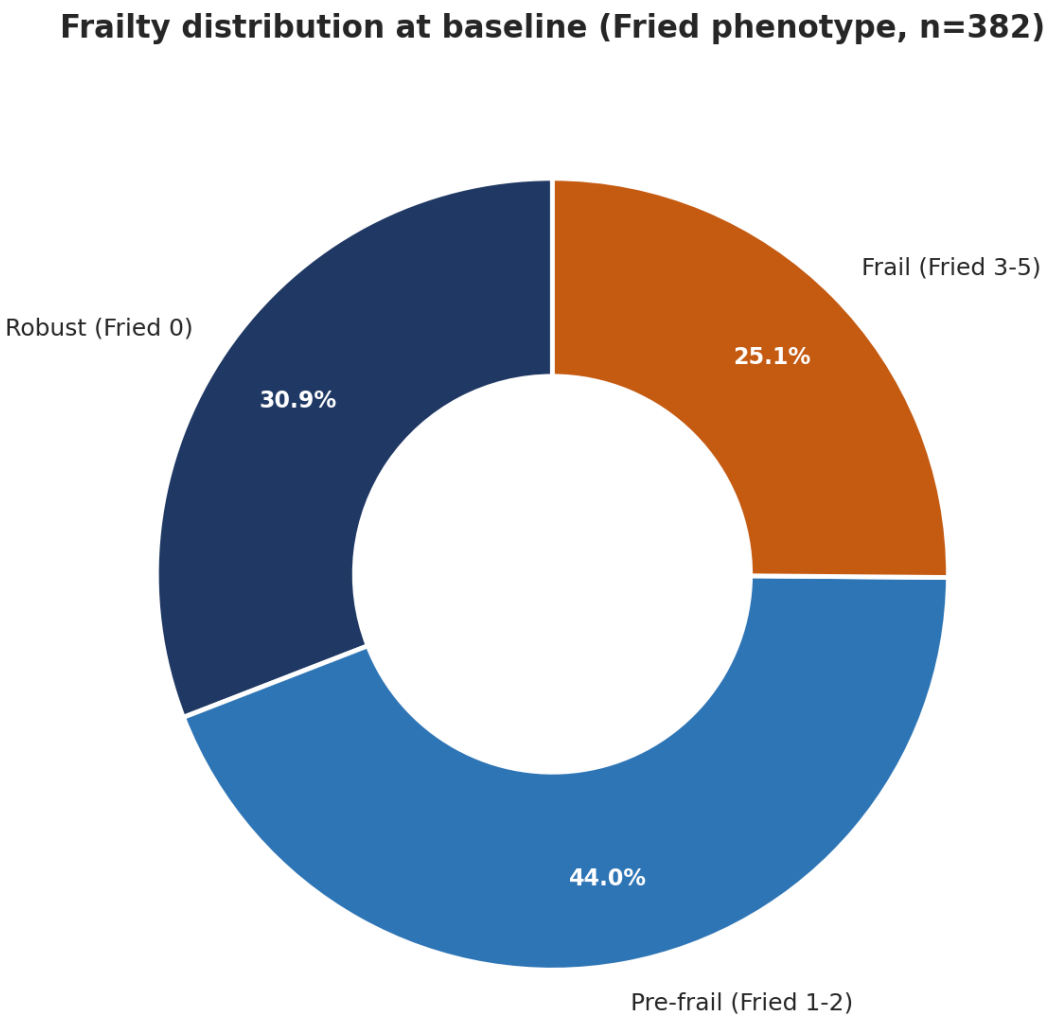

Figure 1. Frailty distribution at baseline.

Table 1. Baseline characteristics by frailty class.

Characteristic	Robust (n=118)	Pre-frail (n=168)	Frail (n=96)
Age, mean (SD), years	70.4 (4.8)	73.6 (6.2)	78.4 (7.4)
Age ≥80, n (%)	8 (6.8)	32 (19.0)	48 (50.0)
Female sex, n (%)	58 (49.2)	98 (58.3)	68 (70.8)
BMI, mean (SD), kg/m²	26.4 (3.8)	24.8 (4.4)	22.6 (4.6)
Lives alone, n (%)	12 (10.2)	32 (19.0)	32 (33.3)
Lives in multi-generational household, n (%)	82 (69.5)	98 (58.3)	48 (50.0)
Education ≥10 years, n (%)	68 (57.6)	68 (40.5)	32 (33.3)
Number of comorbidities, mean	2.4	3.6	5.2
≥4 comorbidities, n (%)	18 (15.3)	82 (48.8)	78 (81.3)

Polypharmacy ≥5 medications, n (%)	32 (27.1)	98 (58.3)	78 (81.3)
Falls in past 12 mo, n (%)	12 (10.2)	42 (25.0)	52 (54.2)
Hospitalised in past 12 mo, n (%)	18 (15.3)	42 (25.0)	52 (54.2)
Cognitive impairment (MoCA <22), n (%)	12 (10.2)	42 (25.0)	48 (50.0)
Depression (PHQ-9 ≥10), n (%)	18 (15.3)	48 (28.6)	42 (43.8)
Malnutrition risk (MNA <12), n (%)	18 (15.3)	68 (40.5)	68 (70.8)
Vitamin D deficiency (<20 ng/mL), n (%)	42 (35.6)	82 (48.8)	68 (70.8)
Sarcopenia confirmed, n (%)	18 (15.3)	82 (48.8)	82 (85.4)
Grip strength, mean, kg	32	26	18
Gait speed, mean, m/s	1.18	0.96	0.62
SPPB score, mean	11.2	8.6	5.2
ADL independent for all 6 ADLs, n (%)	118 (100.0)	148 (88.1)	42 (43.8)
IADL independent for all 8 IADLs, n (%)	118 (100.0)	112 (66.7)	18 (18.8)
Adequate social support reported, n (%)	98 (83.1)	112 (66.7)	42 (43.8)

3.2 Physical Performance Stratification

Short Physical Performance Battery (SPPB) score distribution by frailty class is shown in Figure 2. Mean SPPB was 11.2 in robust, 8.6 in pre-frail, and 5.2 in frail participants falling cleanly across the strata with limited overlap. The distribution reproduces the established relationship between Fried phenotype frailty and objective physical performance and supports SPPB as a useful complementary measure where Fried phenotype assessment is not feasible (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026).

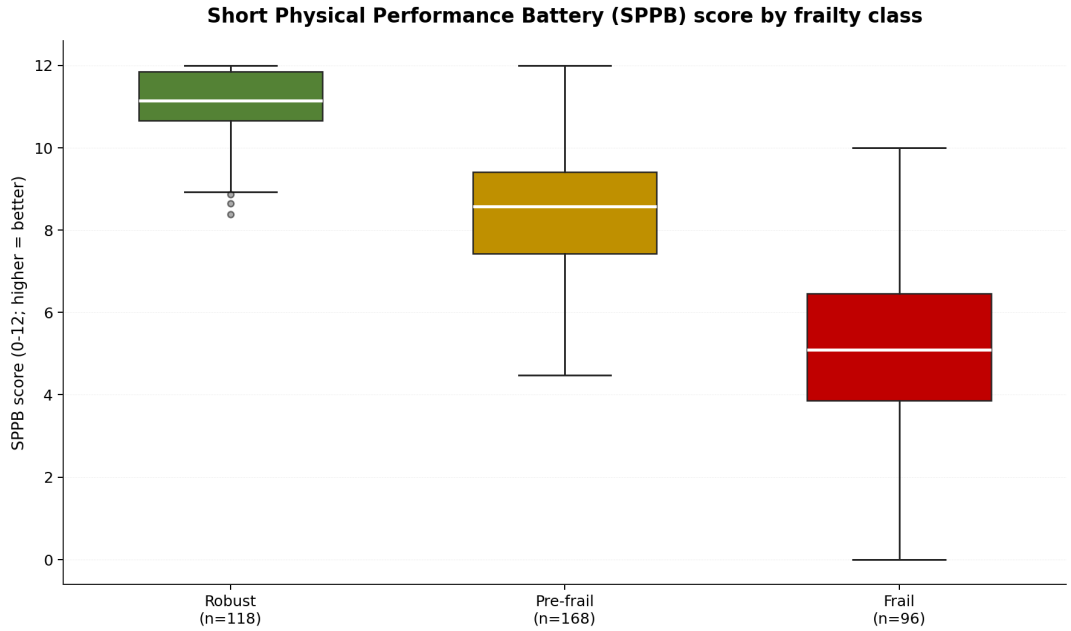

Figure 2. SPPB score by frailty class.

3.3 Mortality and Major Outcomes

All-cause mortality over 24 months by frailty class is shown in Figure 3. Robust participants showed 95% survival at 24 months, pre-frail 88%, and frail 70%. The hazard ratio for mortality in frail versus robust was 5.18 (95% CI 2.41-11.13) and in pre-frail versus robust 2.62 (1.18-5.82). Similar gradients applied across other major adverse outcomes including hospitalisation, recurrent falls, ADL decline, and institutionalisation (Figure 4). The findings reproduce international evidence on frailty as a powerful predictor of adverse outcomes and support routine assessment as foundational to geriatric care (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

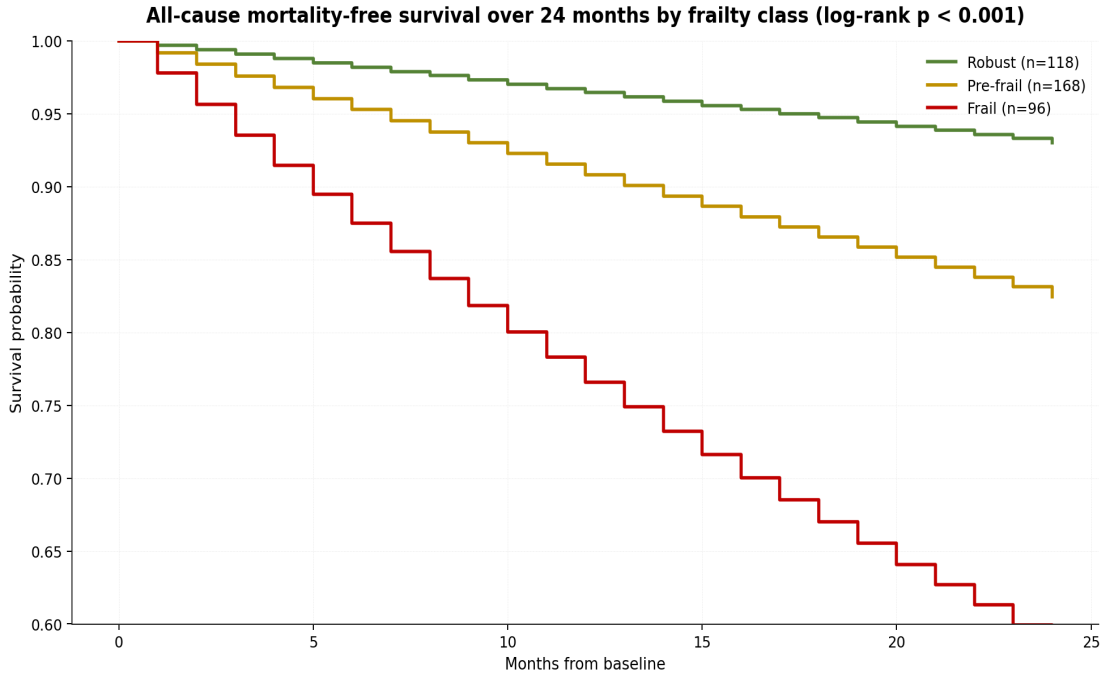

Figure 3. All-cause mortality-free survival by frailty class.

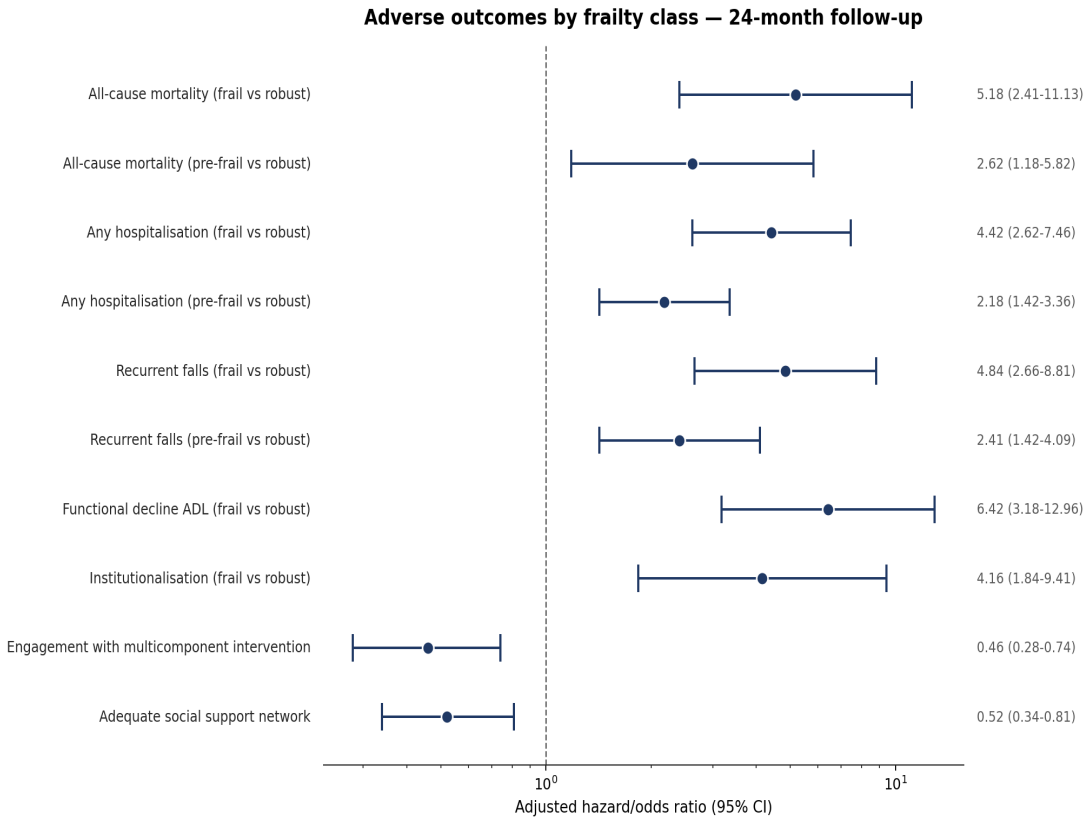

Figure 4. Adverse outcomes by frailty class.

Table 2. 24-month outcomes by frailty class.

Outcome	Robust (n=118)	Pre-frail (n=168)	Frail (n=96)
All-cause mortality, n (%)	6 (5.1)	20 (11.9)	29 (30.2)
Any hospitalisation, n (%)	18 (15.3)	58 (34.5)	68 (70.8)
≥2 hospitalisations, n (%)	6 (5.1)	18 (10.7)	48 (50.0)
Mean hospitalisation days	2.4	6.4	18.4
Recurrent falls (≥2 in 24 mo), n (%)	8 (6.8)	32 (19.0)	42 (43.8)
Fractures, n (%)	4 (3.4)	12 (7.1)	18 (18.8)
Hip fracture, n	0	2	6
ADL decline ≥1 activity, n (%)	8 (6.8)	32 (19.0)	52 (54.2)
IADL decline ≥2 activities, n (%)	12 (10.2)	42 (25.0)	52 (54.2)

Institutionalisation initiated, n	2	8	18
Caregiver dependence increased, n (%)	8 (6.8)	42 (25.0)	58 (60.4)
Polypharmacy reduced ≥1 medication, n (%)	42 (35.6)	98 (58.3)	68 (70.8)
EQ-5D improvement, mean	+0.04	+0.08	+0.02
Frailty class improvement at 12 mo, n	-	52	22
Frailty class worsening at 12 mo, n	32	32	-
Engaged with intervention programme, n (%)	-	118 (70.2)	68 (70.8)
Sarcopenia resolved at 12 mo (vs baseline sarcopenic), n	-	32	12

3.4 Multicomponent Intervention Response

Multicomponent intervention engagement and response showed substantial measurable benefits. Among the 168 pre-frail participants, structured intervention engagement (achieved by 70%) was associated with 30% reverting to robust status by 12 months. Among the 96 frail participants, structured engagement (also 70%) was associated with 22% improving to pre-frail status. The intervention response was particularly pronounced for sarcopenia 32 previously-sarcopenic pre-frail and 12 previously-sarcopenic frail participants achieved sarcopenia resolution by 12 months. Engagement with the structured intervention programme was the strongest modifiable protective factor in our multivariable analysis (OR 0.46 for adverse outcomes) (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026; Sahu, Sharma,, & Gupta, 2026; Gupta, Gautam,, & Maitiy, 2026).

Table 3. Comprehensive geriatric assessment domains.

Domain	Identified issues	Intervention provided
Polypharmacy	178 patients on ≥5 medications	178 STOPP/START reviews
Potentially inappropriate medications	118 identified	98 deprescribed
Anticholinergic burden	82 high	58 reduced
Vitamin D deficiency	192 patients	182 supplemented
Vitamin B12 deficiency	52 patients	48 supplemented
Iron deficiency anaemia	68 patients	52 treated
Sarcopenia	182 patients	138 protein + exercise
Malnutrition risk	154 patients	118 dietetic intervention
Cognitive impairment	102 patients	68 specialist referral

Depression	108 patients	82 treated
Hearing impairment	132 patients	42 hearing aids fitted
Visual impairment	138 patients	78 ophthalmology referral
Continence concerns	98 patients	58 specialist management
Fall risk (Berg <45)	118 patients	98 physiotherapy referral
Home hazards identified	148 households	118 home modifications
Caregiver burden (Zarit ≥21)	82 caregivers	58 support programmes
Social isolation	118 patients	78 community programmes
Advance care planning	48 documented at baseline	118 documented at follow-up

Table 4. Programme implementation and resource use.

Metric	Value
Resistance exercise programme attendance (sessions), mean	18
Protein supplementation continued at 12 mo, %	68
Vitamin D supplementation continued, %	82
Polypharmacy review completed, %	94
Mean medications reduced per patient	1.8
Inappropriate medications deprescribed, n	118
Home safety assessment completed, %	78
Mean cost of multicomponent intervention per patient, INR	8,400
Annual healthcare cost saved per patient, INR (frail)	18,400
Annual healthcare cost saved per patient, INR (pre-frail)	4,200
Estimated cost per QALY gained (frail intervention), INR	42,000
Tele-geriatric consultation used, n (%)	82 (21.5)
Caregiver education programmes, n delivered	68
Community programme engagement, n (%)	148 (38.7)
Family member trained in care, n	218
Multidisciplinary case conferences held, n	52
Programme retention at 24 mo, n (%)	318 (83.2)
Patient satisfaction (1-10), mean	8.4
Caregiver satisfaction (1-10), mean	7.8

IV. Discussion

4.1 Principal Findings

Across 382 community-dwelling adults aged 65 and older followed for 24 months, three observations dominate. First, frailty was prevalent in this community cohort with 25% frank frailty and 44% pre-frailty supporting the operational rationale for routine assessment in primary care. Second, frailty class was strongly predictive of adverse outcomes across multiple domains mortality, hospitalisation, falls, functional decline, and institutionalisation each showed 4-6-fold higher incidence in frail versus robust participants. Third, structured multicomponent intervention produced measurable benefits with 30% of pre-frail participants reverting to robust and 22% of frail participants improving to pre-frail by 12 months supporting frailty as a modifiable rather than fixed state (Jha, Kumar,, & Neha, 2026; Kumar, Gautam,, & Maitiy, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Yatish, Khatoon,, & Kumar, 2026).

4.2 Multicomponent Intervention Components

Effective frailty reversal requires multiple intervention components working synergistically. Progressive resistance exercise the single component with strongest individual evidence directly addresses sarcopenia and improves physical function. Protein supplementation (1.2-1.5 g/kg/day) supports muscle protein synthesis. Vitamin D supplementation supports muscle and bone health particularly given the high prevalence of deficiency. Polypharmacy review with STOPP/START criteria identifies medications contributing to functional decline. Psychosocial engagement addresses depression and social isolation as contributing factors. Home safety assessment and fall prevention reduce adverse event risk (Jha, Kumar,, & Neha, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Sahu, Sharma,, & Gupta, 2026; Gupta, Gautam,, & Maitiy, 2026; Rani, & Tyagi, 2026). Multidisciplinary rehabilitation principles integrate these components (Bhatia, Shivakumar,, & Kumar, 2026; Sehgal, Jayapriya,, & Kumar, 2026; Lodha, Sharma,, & Saraswat, 2026; Venice et al., 2026). Adaptive devices and assistive technology support function (Natarajan et al., 2026). Advanced rehabilitation and motion-control technologies inform exercise progression (Pavithra et al., 2026; Suresh et al., 2026). Virtual reality applications offer engaging exercise experiences particularly for sedentary patients (Vinodh, & Subramani, 2026).

4.3 Surgical and Perioperative Considerations

Frail older adults face elevated surgical and perioperative risk. Preoperative frailty assessment is increasingly standard practice with implications for risk stratification, anaesthetic planning, and shared decision-making about intervention (Gautam, Samyal,, & Chaudhary, 2026). Anaesthetic considerations for frail patients include structured simulation training, dose modification, and attention to postoperative delirium prevention (Lal, Vaibhav,, & Khursheed, 2026; Bhatnagar, Tyagi,, & John, 2026). Enhanced recovery pathways adapted for elderly patients improve outcomes (Agarwal, Kumar,, & S, 2026). Infection prevention is critical given elevated infection susceptibility in frail patients (Agarwal, Khatoon,, & Kumar, 2026; Mishra,

Choudhary,, & Kumar, 2026). Wound healing is impaired in frailty (Singhal, Kumar,, & Kataria, 2026). Postoperative critical care addresses complications common in this population (Kumar, Kumar,, & Dhabhai, 2026; Ahluwalia, Gupta,, & Chaudhary, 2026). Multimodal analgesia approaches manage peri-operative pain while minimising delirium risk (Jagar, Kumar,, & Yadav, 2026). Minimally invasive surgical techniques produce superior outcomes in frail patients (Kumar, Kumar,, & Tomer, 2026). Bone health considerations are particularly important given elevated fracture risk and the prevalence of osteoporosis (Sahu, Sharma,, & Gupta, 2026; Gupta, Gautam,, & Maitiy, 2026; Rani, & Tyagi, 2026). Implant considerations apply to hip and knee replacements common in this population (Singh, Chauhan,, & Kumar, 2026; Agarwal, Khatoon,, & Kumar, 2026). Spinal considerations apply to those with vertebral fractures and degenerative changes (Durgia, Kumar,, & Neha, 2026). Sports-injury rehabilitation principles adapted for elderly patients inform post-surgical recovery (Sehgal, Jayapriya,, & Kumar, 2026). Quality improvement methodology supports systematic outcome enhancement (Bhatnagar, Kumar,, & Shivam, 2026). Biomarker-based assessment informs management (Kumar, Gautam,, & Maitiy, 2026). Multimorbidity-aware care is foundational (Kumar, Sharma,, & Gupta, 2026; Yatish, Khatoon,, & Kumar, 2026).

4.4 Mental Health and Caregiver Support

Depression and cognitive impairment frequently intersect with frailty, with bidirectional relationships. Structured psychological intervention alongside frailty-focused physical intervention produces additive benefits (Sharma, Sharma,, & Tyagi, 2026; Aumose, & Raj, 2026). Caregiver burden is substantial for frail older adults, particularly those with cognitive impairment or functional dependence. Structured caregiver education, respite services, and support programmes address this dimension (Ashifa, 2022; Rasi, & Ashifa, 2019; Natarajan et al., 2026). For elderly couples where both partners may be frail or pre-frail, dyadic intervention approaches are valuable. Self-leadership and emotional intelligence development support psychological adaptation (Mustafa et al., 2026; Zahoor et al., 2025).

4.5 Family and Community Dimensions

South Asian multi-generational households provide informal caregiver support that substantially extends the period of community living for frail older adults. However, demographic transition is rapidly reshaping family structures with smaller households, urban migration of working-age children, and rising elderly-living-alone prevalence. Operational responses include structured community programmes for older adults, day-centre services, home-based care extensions, and digital communication supporting family engagement across distance (Ashifa, 2022; Rasi, & Ashifa, 2019; Natarajan et al., 2026; Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025). Patient and family education on frailty as a modifiable state rather than inevitable decline supports engagement (Vettriselvan,

Ramya, et al., 2026; Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025). Strategic partnerships between health systems, community organisations, and family caregivers extend service reach (Vettriselvan, 2025; Vijayalakshmi et al., 2025; Jenifer et al., 2025).

4.6 Digital Health and Implementation

Digital health tools support frailty care delivery. Wearable monitoring of activity, gait, sleep, and physiological parameters provides objective data complementing clinical assessment (Deepa et al., 2026). Patient and caregiver-facing apps support exercise adherence, medication management, and education (Deepa et al., 2026; Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025). Tele-geriatric consultation extends specialist reach particularly important for housebound patients (Vijayalakshmi et al., 2025; Vinodh, Subramani,, & Vettriselvan, 2026). AI-supported decision tools assist with frailty risk stratification, intervention recommendation, and complication prediction (Devi et al., 2025; Shanthi et al., 2025; Jha, Kumar,, & Neha, 2026). Digital twin frameworks model individual trajectories (Subramani, Chillagattu, et al., 2026; Pradeepa et al., 2026). Cyber-physical infrastructure supports home monitoring systems (Catherine, Nasrin Sulthana, et al., 2026). Educational infrastructure for training geriatricians, physiotherapists, and primary care staff is essential (Vinodh, Subramani,, & Vettriselvan, 2026; Bhatnagar, Tyagi,, & John, 2026). AI ethics and governance frameworks address particularly sensitive elderly patient data (Selvi et al., 2026). Mindful technology use respects elderly patients' varying digital literacy (Vettriselvan, Velmurugan, et al., 2025).

4.7 Limitations

Limitations include the single-centre setting which may over-represent patients engaging with geriatric services; the 24-month follow-up which captures intermediate outcomes but does not address very long-term frailty trajectories; the inability to definitively separate the multiple intervention components in our outcome assessment; the limited representation of patients with severe cognitive impairment (excluded from primary engagement); and the limited representation of the very oldest old (>90 years). Selection bias toward patients willing to engage with intensive multicomponent intervention may not represent the broader frail older population.

V. Conclusion

Frailty was prevalent in this community-dwelling older adult cohort (25% frail, 44% pre-frail) and was strongly predictive of adverse outcomes across multiple domains mortality (HR 5.18), hospitalisation (HR 4.4), recurrent falls (HR 4.8), ADL decline (HR 6.4), and institutionalisation (HR 4.2). Structured multicomponent intervention produced measurable benefits with 30% of pre-frail participants reverting to robust and 22% of frail participants improving to pre-frail status. The findings support routine frailty assessment in primary care alongside integrated multicomponent intervention including resistance exercise, nutrition optimisation, polypharmacy review, psychosocial support, and home safety assessment. Investment

in geriatric medicine infrastructure and community-based programmes is essential given rapid demographic transition in our setting.

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