Original Article

Health Decline in Older Adults

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Background : While it is widely recognized that health declines with an increase in age, the rate of this decline may depend not only on the host but also on several environmental factors. Variability in health status and the risk for adverse outcomes for people of the same age are also recognized as frailty. The rate of health decline is an important consideration for functional healthy ageing. The present cohort study evaluated the rate of health decline in older adults and explored the factors associated with a faster decline.

Methods : Older adults visiting our clinic were included in a dynamic cohort and were evaluated on a 74-point score of previously identified indicators over a period of one year. Various clinical and biochemical factors associated with a faster health decline were further assessed in a logistic regression model analysis.

Observations : A total of 101 participants (51 males and 50 females) with a mean age of 65.4 (±5.4) years and a BMI of 22.2 (±3.2) kg/m^2 participated in the study. The median count of negative health indicators was nine (IQR; 5,13) which increased to ten (IQR; 5, 14) at the end of one year. The medial change was one (IQR; 0, 2). Frailty score, Deficit count and Depression score at baseline were associated with a faster health decline.

Conclusion : A knowledge of factors associated with a faster health decline allows appropriate resource allocation to ensure healthy ageing.

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***Key words* : Frailty, Frailty score, Rate of health decline.**

Morbidity in older individuals is due to the accumulation of health deficits and may not be directly related to the numerical biological age of the individual. Initial impressions have indicated that a decline in an individual's health is closely related to progressive ageing because increasing age is closely related to the accumulation of health deficits[1]. Worldwide, the proportion of the elderly population has risen rapidly from 6 per cent in 1990 to 9 per cent in 2019; is said to rise further to 16 per cent by 2050[2]. In India, the older individuals grow at a rate three times higher than the population as a whole[3]. It is estimated that the rapidly ageing population's economic burden in terms of health-related needs as well as retirement programs is estimated to impact the tax revenue making it 11% higher by 2050[4]. However, the adoption of approaches toward healthy ageing could offset this anticipated expense to the exchequer[5].

Editor's Comment :

- We calculate the rate of accumulation of health deficits in older adults, which is rarely studied.
- We explore the factors associated with rapid health deficit accumulation.
- *Why does this paper matter ?* Knowledge about the rate of accumulation of health deficits as well as clinical and biochemical factors associated with a faster rate will develop targeted therapies for the older population. Thus, reducing frailty and its associated economic outcome

World Health Organization (WHO) has defined healthy ageing as "the process of developing and maintaining the functional ability that enables wellbeing in older age" ,according to WHO, the concept of healthy ageing revolves around two key discussions, *Diversity* and *Inequity*[6]. Diversity highlights the broad range of functioning capacity in individuals from the same age group; while inequity implicates this diversity in functioning to the variable factors in a person's life. Additionally, the WHO describes five domains to assess the Quality Of Life (QOL): Physical and Functional abilities, Social Interactions, Psychological

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status, Religious and spiritual status and Economic and Vocational status[7]. Focusing on factors that impact QOL as well as knowledge of deficient accumulation rate coupled with factors associated with rapid accumulation, could guide in preventing and handling complex health problems in an ageing population.

Frailty is defined by Fried, *et al* acts as an independent risk factor for poor health outcomes[8]. In a systematic review, Collard, *et al* found that the prevalence of frailty in community-dwelling older people varies from 4.0% to 59.1%[9]. In studies that used broad definitions or measurement instruments, the overall weighted average prevalence has been calculated as 10.7% (95% CI = 10.5-10.9%; 21 studies; 61,500 participants)[9]. An Indian study, including 250 older hospitalized subjects identified 83 (33.2%) frail participants who had a higher median hospital stay with multiple co-morbid conditions and higher mortality[10]. Random molecular damage that progressively accumulates with age is responsible for the process of ageing. Mechanisms for frailty include damage at the cellular level causing tissue dysfunction, by reactive oxidative species, exposure to UV light, and toxins. Concomitant factors like epigenetics, genetics, diet, social interaction and physical activity also impact the rate of deficit accumulation. Variability in these factors explains heterogeneity in functioning and disease states of people from the same age group[11]. However, the rate of accumulation of health deficits has been seldom studied and factors associated with the rapid deterioration remain unexplored.

It has been suggested that an individual's health status can be represented by the number of health deficits (broadly defined by biological and clinical characteristics) as they accumulate. Counting deficits allows health to be conceptualized in a single number, the Frailty Index (FI). This method appears to be robust since inferences do not depend on whether the data use self-reported, clinical or performance-based frailty indices. The current study aimed to calculate the rate of accumulation of health deficits in an Indian community-dwelling population while also attempting to identify the clinical and biochemical factors associated with a faster rate of accumulation.

Materials and Methods

Subjects older than 60 years visiting the outpatient clinics for one or more comorbid conditions requiring monitoring or therapy were included in a dynamic cohort after a due informed consent process. Acutely ill patients who could not be evaluated and those needing hospitalization were excluded. Those who could not provide a viable also phone number for future contact were excluded (Fig 1).

Health indicators were determined at the time of recruitment and during follow-up visits. Subjects were assessed with the aid of a pre-designed performa which included the count of 74 previously defined health indicators. The participants were also graded based on the Fried frailty phenotype[8]. The health indicators included a mix of subjective, objective and laboratory characteristics. It has been shown earlier that a frailty index derived from a deficit count has always predicted mortality better than the simple use of age and this approach has been independently validated[12,13]. The questionnaire developed included standard items like examination of Blood Pressure, Pallor, Oedema, Heart Rate, Crepitations, Ascites, Murmur, Neurological Weakness, Medication History Including Pill Burden, Mmse Score, Body Mass Index (BMI), Get-up-and-go test and Barthel's score[14-19].

Laboratory parameters included estimation of Haemoglobin, Total Leucocyte Count, Blood Urea, Serum Creatinine, Fasting Blood Sugar, Serum Calcium, Serum Bilirubin, And Total Cholesterol. To indicate severity, each parameter was not restricted by its nature to two values (ie, 0 or 1 for absence or presence, respectively) and was assigned three (0, 0.5, or 1)

The statistical analysis was done on Stata version 13 (StataCorp, TX, USA). The baseline characteristics were presented as mean (Standard Deviation) or number (percentage). Differences between baseline and one-year measures were evaluated using paired t-test or Chi-square test, as appropriate. The decline in health was reported by counting the newly accumulated indicators over baseline at the end of one year. The relation between health decline and other parameters was evaluated using regression techniques. The distribution of change as estimated

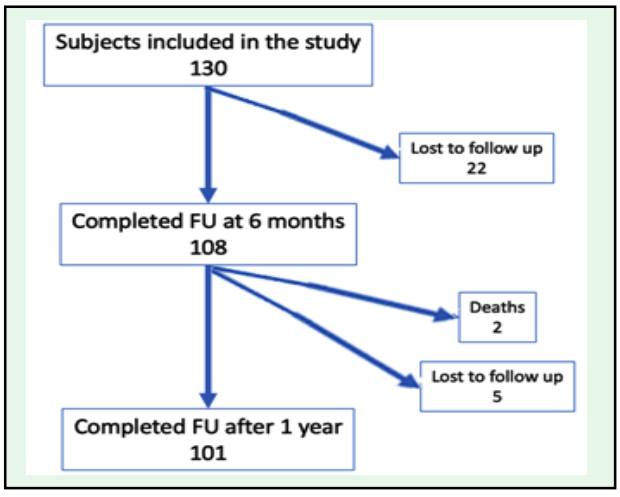

Fig 1 — Flowchart of Study

by the subtraction was studied using histograms and a value at the 90th percentile in the data was considered to define the *fast accumulation* of deficits. The change in the count was modelled as the dependent outcome variable in logistic regression analysis and the baseline count was with other independent risk factors.

Results

Baseline Characteristics :

A total of 101 community living participants older than 60 years, with comorbidities visiting our outpatient clinics for medications, completed one-year follow up in a dynamic cohort. The mean age of the study subjects was 65.4 (±5.4) years with a maximum age of 80 years. There were 51 males and 50 females. The mean BMI of the participants was 22.2 (±3.2) kg/m^2.

The median deficit count noted at baseline was 9 (IQR; 5, 13). A total of 13 (12.9%) participants were frail at baseline with three or more features on the Fried phenotype score[8]. A similar number (13, 12.9%) had features of depression. The median number of pills being taken by the participants was 6 (IQR; 4, 9).

Health Decline in One Year :

At the end of one year, the median deficit count was ten (IQR; 5,14). A total of 23 (22.8%) were now found to be frail and 21 (20.8%) had features of depression. The median pill burden increased to seven (IQR; 5,9). The details of the baseline characteristics of all participants and the changes acquired in one year are presented in Table 1.

Significant changes were noted over one year in Depression Score, Pill Burden, Get-up-and-go Test, Walking Speed, QOL Score, Frailty Score, Deficit Count, Haemoglobin, TLC, Blood Urea, Fasting Blood Sugar, and Serum Calcium. There were no significant changes in BMI and hand-grip strength.

Speed of Health Decline or Rate of Accumulation of Deficits :

The distribution of the total deficits was assessed at each follow-up visit and we recorded that the 90th percentile of the observations was 3 (range -2, 6). Most subjects were found to have accumulated 3 or fewer additional health deficits over baseline in one year. For our analysis, we surmised that if the change in deficit count was more than three, this was considered a '*fast change*' or rapid accumulation of deficits. If the change in deficit count was less than or equal to three, this was regarded as *slow change* or a relatively 'stable' condition.

Table 1 — *Baseline Distribution of variables and changes over time*

Variable	Baseline Mean (SD)	FU 6 months Mean (SD)	FU 1 year Mean (SD)	P value
BMI	22.55(3.20)	22.57(3.21)	22.68(3.22)	0.168
Depression score	0.65(1.39)	0.78(1.38)	0.94(1.37)	<0.001*
Pill burden	6.58(3.17)	6.72(3.10)	7.00(3.09)	<0.001*
Get-up-and-go test	12.42(3.26)	13.12(3.38)	13.19(3.65)	<0.001*
Hand-grip strength	26.90(8.76)	26.89(8.80)	26.22(8.66)	0.064
Walking speed	6.3(2.1)	6.5(2.3)	6.8(2.4)	<0.001*
QOL score	87.82(10.86)	87.43(10.94)	86.97(10.90)	<0.001*
Frailty score	0.97(1.19)	1.08(1.25)	1.37(1.37)	<0.001*
Deficit count	9.47(6.25)	9.84(6.64)	10.64(7.21)	<0.001*
Hb	12.32(1.13)	12.92(1.22)	13.05(1.65)	<0.001*
TLC	7988.30(2238.37)	7076.60(1931.37)	6464.15(1633.66)	<0.001*
FBS	96.08(31.88)	109.48(30.32)	99.26(33.20)	<0.001*
Urea	17.26(4.66)	26.17(7.64)	26.53(12.59)	<0.001*
Calcium	9.14(0.56)	9.27(0.51)	9.30(0.54)	0.028*

*significant change over one year; BMI - Body Mass Index; QOL - Quality Of Life; Hb - Hemoglobin; TLC - Total Leucocyte Count; FBS - Fasting Blood Sugar; FU - Follow-up

Factors Associated with Faster Health Decline :

The various clinical and biochemical parameters were compared within the fast and slow change group. We found that the Baseline Frailty Score, Baseline Deficit Count and Baseline Depression Score were significantly associated with a more rapid accumulation of health deficits. The details of the comparison are presented in Table 2.

In a logistic regression analysis for faster health decline with baseline deficit count as the exposure of interest, we included age, sex and other risk factors as independent variables. We found that the baseline count of health indicators was significantly associated with a faster health decline after adjusting for measured confounders. The details of the logistic regression analysis are presented in Table 3.

Discussion

We examined the rate of decline of health by counting the rate of accumulation of health deficits in an Indian community-dwelling population over a one-year follow-up and found that the Frailty Score, Deficit Count and Depression Score assessed at baseline, were significantly associated with a faster accumulation of deficits. Further, we found that the rate of decline in health is independently associated with the number of established deficits.

Several authors have reported an age-related decline in health over time across the Globe. In a cohort study, Rockwood, *et al* included 17,276 community-dwelling respondents (15-102 years of age) in Canada and assessed changes in fitness and frailty using a Frailty index in a two-yearly follow-up study[20]. They found the prevalence of frailty in various age

Table 2 — *Comparison of health indicators between subjects with faster health decline and those relatively stable*

Baseline Variables	Slow Change group (n=82)		Fast Change group (n=19)		P Value
	Mean	SD	Mean	SD	
Age	65.30	5.34	66.00	5.70	0.615
BMI	22.28	2.83	23.71	4.38	0.189
Income	9402.44	6239.28	11368.42	9226.84	0.264
Depression Score*	0.51	1.24	1.26	1.82	0.033*
Pill Burden	6.34	3.08	7.63	3.44	0.111
Get-up-and-go test	12.13	3.11	13.63	3.70	0.071
Hand-grip Strength	27.20	8.27	25.63	10.78	0.486
Walking Speed	6.18	1.86	6.89	3.05	0.340
MMSE	25.56	5.59	24.53	6.22	0.478
Barthel's ADL score	19.83	0.68	19.58	0.96	0.294
QOL	88.01	10.94	87.00	10.77	0.716
Overall QOL	6.85	1.16	6.47	1.26	0.208
Frailty Score*	0.76	1.04	1.89	1.37	0.002*
Baseline Deficit Count*	8.41	5.93	14.00	5.66	<0.001*
Hb	12.35	1.06	12.07	1.42	0.324
TLC	7906.10	2248.42	8016.67	2024.92	0.848
FBS	95.76	31.15	96.16	34.47	0.960
Urea	17.52	4.71	15.42	4.05	0.075
Calcium	9.17	0.54	9.07	0.65	0.494

*significant association with fast change

Table 3 — *Logistic regression analysis for fast change*

Variable	Model 1 Crude rates OR (95% CI)	Model 2 With confounders OR (95% CI)	Full Model OR (95% CI)
Baseline deficit count	1.14(1.05-1.24)*	1.20 (1.08-1.32)*	1.21 (1.01-1.46)*
Age		0.98 (0.89-1.09)	1.03 (0.91-1.16)
Sex		0.26 (0.07-1.01)	0.28 (0.04-2.15)
Income		1.00 (1.00-1.00)	1.00 (1.00-1.00)
Pill Burden			0.98 (0.22-4.25)
Get-up-and-go test			1.10 (0.71-1.71)
Handgrip strength			1.06 (0.94-1.19)
Walking speed			0.82 (0.43-1.58)
Feels less active			2.00 (0.28-14.14)
MMSE score			0.86 (0.72-1.03)
Barthel's ADL Score			1.00 (0.43-2.34)
QOL score			1.04 (0.97-1.12)

OR-Odds Ratio, CI-Confidence Interval, * significant association with fast change

groups. They reported a prevalence of 2.0% among those younger than 30 years, 22.4% for those older than age 65, including 43.7% for those 85 and older. Additionally, they found that a larger proportion of frail individuals were users of healthcare services while relatively fit people performed better over time.

Diehr, *et al* recruited Medicare-eligible individuals from four American communities, in a cohort of 5,201 participants and 687 African Americans[21]. They compared the 5-year change to measure the rate of decline in 13 measures of Physical, Mental and Functional Health. They reported a 5-year change in standardized health varied from a decline of 12 points (out of 100) for hospitalization to a decline of 17 points for gait speed.

Similarly, Armstrong, *et al* studied the deficit accumulation in a male cohort of 3,801 older Japanese-American men and calculated Frailty Indices (FIs) across six waves and the distribution at each wave were evaluated to see the pattern between FI and age[22]. At each wave, frailty was nonlinearly associated with age and acceleration was noticed in later years of life. The distributions of the FIs were skewed with long right tails. Despite the increased mortality in each successive wave, the 99% submaximal limit never exceeded 0.65. The risk of death increased with increasing values of the FI (eg, the hazard rate increased by 1.44 [95% CI = 1.39-1.49] with each increment in the baseline FI grouping). Depending on the wave, the median survival of people with FI more than 0.5 ranged from 0.84 to 2.04 years.

Our results augment the previously reported association between baseline health and the speed of further decline with acceleration in later years. In addition, we have quantified the rate of decline using a time-sensitive analysis in our study. We had a relatively younger set of participants in our cohort who were followed for a year while evaluating an increment on 74 health variables in a deficit count. We found that the Baseline Frailty Score, Baseline Deficit Count and Baseline Depression Score were significantly associated with a faster rate of accumulation of further deficits. Ours is the first Indian study to record a change in health by measuring the deficits in a cohort of older people and associating this with baseline counts as well as component individual deficits by applying a regression analysis approach.

Our study was limited by the inclusion of a convenience sample of relatively healthier older individuals visiting the hospital for chronic ailments who were relatively easier to follow. Less robust individuals were not able to visit the hospital and consequently were not included. Logistic considerations restricted our sample size while our results do indicate a need for a larger study to explore the nuances of the associations we have uncovered.

Conclusion

The knowledge around the rate of decline in health by way of accumulation of health deficits and factors associated with this decline allows healthcare workers to focus on therapies to promote healthy and functional ageing strategies for older persons. This will not only help target therapies to older individuals based on their

baseline health function but also reduce the economic burden on society by improving the dependence requirements.

Ethical Standards : The experiments and practices associated with this study comply with the current laws of the country in which they were performed.This study could proceed only after the approval of the Institutional Ethics Committee - Human Research Cell of the University College of Medical Sciences. University of Delhi, Delhi

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Impact Statement : The rate of accumulation of health deficits has been seldom studied and factors associated with the rapid deterioration remain unexplored. Our study is aimed to calculate the rate of accumulation of health deficits in an Indian community-dwelling population while also attempting to identify the clinical and biochemical factors associated with a faster rate of accumulation. This helps target therapies to older individuals based on their baseline health function but also reduces the economic burden on society by improving the dependence requirements.

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