Applied nutritional investigation

Long-term changes in nutritional status are associated with functional and mortality outcomes among community-living older adults

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ABSTRACT

Objectives: Older adults who are malnourished are at high risk for adverse functional and mortality outcomes. The aim of this study was to assess the long-term changes in nutritional status among community-living older adults and their associations with adverse health outcomes.
Methods: This was a population-based observational cohort study (Singapore Longitudinal Aging Study, SLAS 1), with a 4- to 5-y follow-up of 2075 community-living adults ≥60 y of age. Nutritional status (Mini Nutritional Assessment Short-Form [MNA-SF] and Nutritional Screening Initiative [NSI]), instrumental/basic activities of daily living (IADLs/ADLs) and quality of life (QoL) were assessed at both baseline and at the 4- to 5-y follow-up. The 10-y mortality was assessed from the date of 4- to 5-y follow-up to March 2017. Estimates of associations between changes in nutritional status and adverse health outcomes were analyzed using multinomial logistic regression or Cox proportional hazards regression, and indicated by odds ratios/hazard ratios (ORs/HRs) and 95% confidence intervals (CIs).
Results: Nutritional status was dynamic from baseline to the 4- to 5-y follow-up according to both MNA-SF and NSI. Compared with persistent normal nutrition, nutritional deterioration was associated with increased incident IADL/ADL disability (MNA-SF: OR, 3.22; 95% CI, 1.13–9.16), poor QoL (MNA-SF: OR, 4.53; 95% CI 2.13–9.64), and mortality (MNA-SF: HR, 4.76; 95% CI, 2.82–8.03; NSI: HR, 1.99; 95% CI, 1.27–3.14); nutritional improvement was associated with decreased incident IADL/ADL disability (NSI: OR, 0.17; 95% CI, 0.05–0.59); persistent poor nutrition (MNA-SF at risk/malnourished or NSI moderate/high nutritional risk) was associated with elevated incidence of poor QoL (MNA-SF: OR, 1.92,; 95% CI, 1.05–3.52; NSI: OR, 2.31; 95% CI, 1.19–4.49) and mortality (MNA-SF: HR, 2.57; 95% CI, 1.59–4.15; NSI: HR 1.97; 95% CI, 1.17–3.32). Compared with persistent poor nutrition, nutritional improvement was also associated with decreased incidence of mortality (MNA-SF: HR, 0.43; 95% CI, 0.23–0.80).
Conclusions: Changes in nutritional status are associated with adverse health outcomes, and should be monitored with simple screening tools to identify older adults at high risk for adverse functional and mortality outcomes for selective nutritional interventions.

Introduction

Malnutrition is an adverse health condition mostly reflecting inadequate nutrient availability to meet the physiologic demands of the body. It is especially more common in older individuals because of age-related psychological and physiologic changes causing decreased appetite and food perception, inadequate food (protein-calorie and micronutrients) intake, impaired absorption and metabolism, chronic diseases, polypharmacy, and functional disability [1,2]. Pooled estimates across studies using the Mini Nutritional Assessment (MNA) tool put the prevalence of malnutrition at ∼20% globally, varying from 5.8% in the community to 50.5% in clinical and long-term care settings [3].

Malnutrition is closely associated with morbidity, hospital length of stay and costs, severity of disability, quality of life (QoL), and survival [4−10]. The large majority of studies are conducted in hospitals and institutional care settings, and population-based studies of community-living older adults are few. Population-based studies show that ∼25% of older adults in the community are at risk of malnutrition, ∼5% are malnourished, and poor nutritional status is associated with increased long-term mortality over 10 y [11−13]. However, little is known about the changes in nutritional status over many years among free-living older adults in the community [14] and whether deterioration or improvement in nutritional status among this population is associated with the risks for functional disability, poor QoL, and mortality.

Methods

Participants

We analyzed data collected from the first wave cohort of the Singapore Longitudinal Ageing Study (SLAS 1). As previously described [15,16], the SLAS is a population-based longitudinal study of aging and health of community-dwelling Singaporeans ≥55 y of age, excluding individuals who were not able to participate because of severe physical or mental disability. SLAS 1 recruited 2804 residents in the southeast region of Singapore at baseline (from September 2003 to December 2005), with a 2- to 3-y follow-up (from March 2005 to September 2007), a 4- to 5-y follow-up (from November 2007 to December 2009), and a follow-up of mortality from December 2009 to March 2017. The study received ethical approval from the National University of Singapore Institutional Review Board, and written informed consent was obtained from all participants. Participants ≥60 y of age (N = 2075) were included in this study.

Measurements

Nutritional status

Nutritional status was assessed at baseline and at the 4- to 5-y follow-up using the Mini Nutritional Assessment Short-Form (MNA-SF) [17,18] and the Nutrition Screening Initiative (NSI, also called DETERMINE Your Nutritional Health checklist) [19−21].

The MNA-SF is a widely used nutrition screening scale in clinical settings. We derived MNA-SF from available data collected in the SLAS 1 cohort [22]. The total weighted MNA-SF scores range from 0 to 14, with 12 to 14 indicating normal nutrition, 8 to 11 indicating being at risk of malnutrition, and ≤7 indicating malnourished.

The NSI Checklist published by the American Academy of Family Physicians, the American Dietetic Association, and the National Council on the Aging in 1991 is a screening and educational tool widely used in United States and other countries to identify community-dwelling older adults at nutritional risk for primary health care interventions [19−21]. It is a 10-item questionnaire describing personal and behavioral factors related to inadequate or poor quality food and nutrient intake among older adults: not enough money to buy needed food; eat alone most of the time; physically unable to shop, cook, and/or feed myself; tooth or mouth problem causes difficulty in eating; less than two meals eaten per day; few fruits or vegetables (less than two portions per day) or milk products (less than once a day); unintended loss of ≥4 kg in the past 6 mo; illlness/condition that changes kind/amount of food eaten; take three or more different drugs a day; and drink three or more alcoholic drinks almost every day. The total weighted scores range from 0 to 21, with ≥6 indicating high nutritional risk, 3 to 5 indicating moderate nutritional risk, and 0 to 2 indicating good nutrition.

Adverse health outcomes

At baseline and at the 4- to 5-year follow-up visit, instrumental or basic activities of daily living (IADL or ADL) disability was determined by self-reported difficulty or need for assistance in one or more IADLs or ADLs; QoL was measured using the Medical Outcomes Study SF12 Physical (PCS) and Mental (MCS) Component Scales [23], and poor QoL was determined by PCS scores below lowest quartile. Mortality data from the date of 4- to 5-y follow-up to March 31, 2017, was obtained using computerized record linkage with the national death registry through the Singapore National Registry of Diseases Office.

Covariates

Sociodemographic data included age, sex, race, education, housing type (an indicator of socioeconomic status), marital status, and living arrangement. The self-report of a medical disorder diagnosed and treated by a physician was recorded for 22 named diagnoses and other disorders. The number of comorbidities was estimated from the total count of medical disorders in the past 1 y. Polypharmacy was defined as the use of five or more medications. Cognitive function was assessed using the Mini-Mental State Examination (MMSE), with a maximum score of 30, where ≥24 indicated normal cognition, 19 to 23 indicated mild cognitive impairment, and ≤18 indicated moderate to severe cognitive impairment [24]. Depressive symptoms were measured by the Geriatric Depression Scale, validated for use in Singaporean participants [25]. With a total score of 15, Geriatric Depression Scale ≥5 indicated clinically significant depression. Physical frailty status was measured using the Fried frailty score (0 = robust, 1−2 = prefrail, 3−5 = frail) derived from measures of body mass loss (body mass index <18.5 kg/m^2 or reported loss of weight >4 kg over 6 mo), low knee extension strength, slow gait, exhaustion, and low physical activity [26]. Hospitalization was measured by self-report of new hospitalization(s) for any medical conditions over the previous year.

Statistical analysis

Categorical variables were presented as percentages and numbers, and continuous variables were presented as means ± SD. Differences in the distribution of categorical variables among groups were tested by χ^2 test. For continuous variables, the F test or Kruskall−Wallis test was used for comparison between different groups. Logistic regression was performed to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) of associations between nutritional status changes and functional disability and poor QoL. Cox proportional hazards regression was performed to calculate the hazard ratios (HRs) and 95% CIs between nutritional status changes and mortality. Kaplan−Meier survival curve was used to compare the survival rates from the date of the 4- to 5-y follow-up to March 31, 2017, among different groups. OR and HR estimates were adjusted for baseline values of age, sex, education level, race, marital status, housing type, current smoking, alcohol drinking, comorbidities, polypharmacy, type 2 diabetes, anemia, chronic obstructive pulmonary disease, hip fracture, cardiac diseases, chronic kidney disease, history of stoke, visual impairment, cognitive impairment, depressive syndromes, hospitalization, and frailty status. The acceptable level of significance was set as two-sided P < 0.05. Stata version 14.0 (StataCorp LP, College Station, TX, USA) was used for data analysis.

Results

Study participant characteristics at baseline

The mean age of the study participants was 69 ± 6.6 y (range: 60−97.6 y). Of the participants 38.8% were men, 59.6% had primary or lower education, 93.3% were Chinese, and 62.8% lived in three- to five-room public housing. MNA-SF showed that 63% had normal nutritional status, 32.6% were at risk of malnutrition, and 4.4% were malnourished. NSI indicated that 66.5% had good nutrition, 28.5% had moderate nutritional risk, and 5% had high nutritional risk (Table 1). The number of participants with complete and missing data at baseline and follow-ups are listed in Supplementary Table 1.

Changes in nutritional status during the 4- to 5-y follow-up

As shown in Table 2, there were deteriorations and improvements of nutritional status (both by MNA-SF and NSI) during the course of the 4- to 5-year follow-up. Among participants with baseline MNA-SF normal nutrition, 7.7% became at risk of malnutrition, and 0.8% became malnourished. NSI estimates of nutritional status deterioration from good nutrition to moderate (23%) and high nutritional risk (1.9%) were higher. Among those with baseline MNA-SF at risk of malnutrition, 0.7% worsened to being

Table 1
Sociodemographic characteristics and prevalence of malnutrition/nutritional risk at baseline

Baseline characteristics	Cohort at baseline		Cohort with 4- to 5-y follow-up of nutritional changes	
	n/Mean	%/SD	n/Mean	%/SD
No. of participants	n = 2075		n = 925	
Age (y)	69.1	±6.60	68.4	±6.03
Male	804	38.8	329	35.6
Education levels				
None	505	24.3	201	21.7
Primary	731	35.2	335	36.2
Secondary/higher	839	40.4	389	42.1
Housing status				
1- to 2-room public housing	143	6.89	60	6.49
3- to 5-room public housing	1304	62.8	590	63.8
High-end public and private housing	628	30.3	275	29.7
Race				
Chinese	1936	93.3	871	94.2
Malay	78	3.76	30	3.24
Indian/Others	61	2.94	24	2.59
Single/Divorced/Widowed	598	28.9	269	29.1
Living alone	163	7.88	79	8.56
Mini Nutritional Assessment Short-Form (MNA-SF)	2023		893	
Normal nutritional status	1274	63	596	66.7
at risk of malnutrition	660	32.6	269	30.1
Malnourished	89	4.40	28	3.14
Nutrition Screening Index (NSI)	2068		925	
Good nutritional status	1375	66.5	644	69.6
Moderate nutritional risk	590	28.5	246	26.6
High nutritional risk	103	4.98	35	3.78

Table 2
Nutritional status transitions from baseline to the 4- to 5-y follow-up

MNA-SF	4- to 5-y follow-up			
	Normal nutrition	at risk of malnutrition	Malnourished	n
Baseline				
Normal nutrition	**91.4 (545)**	7.72 (46)	0.84 (5)	596
at risk of malnutrition	55.4 (149)	**43.9 (118)**	0.74 (2)	269
Malnourished	25.0 (7)	64.3 (18)	**10.7 (3)**	28
N	701	182	10	893

NSI	Good nutrition	Moderate nutritional risk	High nutritional risk	n
Baseline				
Good nutrition	**75.2 (484)**	23.0 (148)	1.86 (12)	644
Moderate nutritional risk	56.1 (138)	**40.2 (99)**	3.66 (9)	246
High nutritional risk	51.4 (18)	42.9 (15)	**5.71 (2)**	35
N	640	262	23	925

MNA-SF, Mini Nutritional Assessment Short-Form; NSI, Nutrition Screening Initiative.
Data shown are % (n).
The proportion and number of participants with unchanged nutritional status were tagged as bold.

malnourished, but 55% improved to normal nutrition. Corresponding higher NSI estimates of baseline moderate nutritional risk deterioration to high nutritional risk was 3.7%, and improvement to good nutrition was 56%. Among those who were MNA-SF malnourished at baseline, 64% improved to being at risk of malnutrition and 25% improved to normal nutrition. NSI estimate of improvement from high to moderate nutritional risk was 43%, and from high nutritional risk to good nutrition was 51%.

Associations with incident adverse health outcomes

Incident IADL or ADL disability

As shown in Figure 1 and Table 3, according to MNA-SF nutritional status, the incidence of IADL or ADL disability among those whose normal nutrition remained unchanged from baseline to the 4- to 5-y follow-up was 7.3%. Those whose nutritional status worsened to being at risk of malnutrition/malnourished showed a significantly increased incidence of IADL or ADL disability (15.8%; OR, 3.22; 95% CI, 1.13−9.16). No significant difference in incidence of IADL or ADL disability was found among those whose MNA-SF nutrition improved from being at risk of malnutrition or malnourished to normal nutrition, or remained unchanged. However, according to NSI nutritional status changes, a statistically significant lower incidence of IADL or ADL disability (3.5%) was found among those with improved nutrition (moderate or high nutritional risk to good nutrition) compared with those whose nutritional status remained at good nutrition (9.8%; OR, 0.17; 95% CI, 0.05−0.59).

Incident poor QoL

Compared with the reference group of MNA-SF, normal nutrition remained unchanged with incidence of poor QoL of 21.6%. Worsened MNA-SF nutrition (from normal nutrition to at risk of malnutrition/malnourished) was associated with
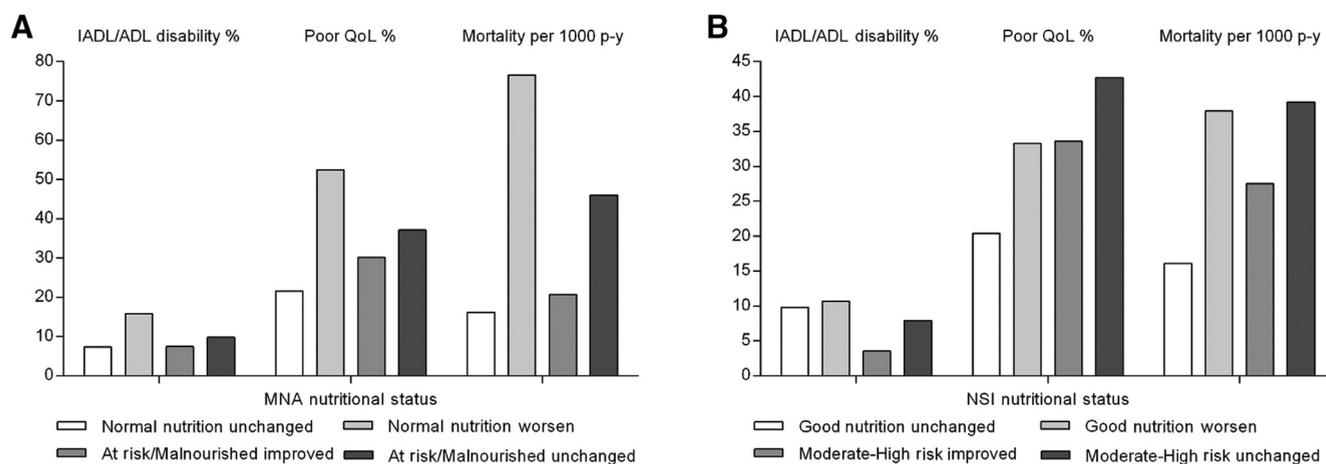
Fig. 1. Rates of functional and mortality outcomes by changes of nutritional status among older adults. (**A**) Changes of nutritional status according to MNA-SF. (**B**) Changes of nutritional status according to NSI. IADL/ADL, instrumental/basic activities of daily living; QoL, quality of life; p-y, person-year; MNA-SF, Mini Nutritional Assessment Short-Form; NSI, Nutrition Screening Initiative.

Table 3
Associations of nutritional status transitions with incident adverse health outcomes at follow-ups

Nutritional Status Transitions		IADL/ADL Disability			Poor Quality of Life			Mortality*		
Baseline	4- to 5-y follow-up	% (n)	OR (95% CI)	P-value	% (n)	OR (95% CI)	P-value	/1000 p-y	HR (95% CI)	P-value
MNA-SF nutritional status		n = 661			n = 671			n = 833		
Normal nutrition	Normal nutrition (unchanged)	7.33 (31)	1.00		21.6 (95)	1.00		16.2	1.00	
Normal nutrition	At risk/Malnutrition (worsen)	15.8 (6)	3.22 (1.13–9.16)	0.029	52.4 (22)	4.53 (2.13–9.64)	<0.001	76.6	4.76 (2.82–8.03)	<0.001
At risk/Malnourished	Normal nutrition (improved)	7.41 (8)	0.78 (0.29–2.11)	0.623	30.1 (28)	1.46 (0.79–2.72)	0.226	20.7	1.33 (0.80–2.20)	0.268
At risk/Malnourished	At risk/Malnutrition (unchanged)	9.78 (9)	1.04 (0.36–3.01)	0.944	37.1 (36)	1.92 (1.05–3.52)	0.035	46	2.57 (1.59–4.15)	<0.001
At risk/Malnourished	Normal nutrition (improved)	7.41 (8)	0.96 (0.23–4.02)	0.958	30.1 (28)	0.91 (0.37–2.25)	0.842	20.7	0.43 (0.23–0.80)	0.007
At risk/Malnourished	At risk/Malnutrition (unchanged)	9.78 (9)	1.00		37.1 (36)	1.00		46	1.00	
NSI nutritional risk		n = 681			n = 687			n = 860		
Good nutrition	Good nutrition (unchanged)	9.77 (38)	1.00		20.4 (81)	1.00		16.1	1.00	
Good nutrition	Moderate/High risk (worsen)	10.7 (11)	0.94 (0.40–2.18)	0.877	33.3 (36)	1.68 (0.98–2.90)	0.060	37.9	1.99 (1.27–3.14)	0.003
Moderate/High risk	Good nutrition (improved)	3.54 (4)	0.17 (0.05–0.59)	0.005	33.6 (36)	1.32 (0.76–2.30)	0.321	27.5	1.29 (0.80–2.07)	0.299
Moderate/High risk	Moderate/High risk (unchanged)	7.89 (6)	0.36 (0.10–1.21)	0.099	42.7 (32)	2.31 (1.19–4.49)	0.013	39.2	1.97 (1.17–3.32)	0.011
Moderate/High risk	Good nutrition (improved)	3.54 (4)	0.21 (0.01–7.92)	0.399	33.6 (36)	0.70 (0.31–1.56)	0.382	27.5	0.59 (0.31–1.10)	0.095
Moderate/High risk	Moderate/High risk (unchanged)	7.89 (6)	1.00		42.7 (32)	1.00		39.2	1.00	

IADL/ADL, instrumental/basic activities of daily living; p-y, person-year; MNA-SF, Mini Nutritional Assessment Short-Form; NSI, Nutrition Screening Initiative.
Adjusted for age, sex, education level, race, marital status, house type, current smoking, alcohol drinking, comorbidities, polypharmacy, type 2 diabetes, anemia, chronic obstructive pulmonary disease, hip fracture, cardiac diseases, chronic kidney disease, history of stoke, visual impairment, cognitive impairment, depressive syndromes, hospitalization, frailty status.
*Mortality was counted from the 4- to 5-y follow-up visit to March 31, 2017.

significantly higher incidence of poor QoL (52.4%; OR, 4.53; 95% CI, 2.13–9.64). Persistent poor nutrition (unchanged at risk of malnutrition/malnourished) was associated with higher incident poor QoL (37.1%; OR, 1.92; 95% CI, 1.05–3.52). A similar pattern of results was obtained with NSI nutritional status transitions of worsened nutritional risk and persistent moderate/high nutritional risk. In addition, NSI change of improved nutritional status (from moderate/high nutritional risk to good nutrition) was associated with lower incidence of poor QoL (33.6%) compared with those at persistent moderate/high

nutritional risk (42.7%; OR, 0.70; 95% CI, 0.31–1.56), although the difference was not significant.

Mortality

The survival curves of different nutrition transition groups (MNA-SF and NSI) are shown in Figure 2. During the 10 y from the date of the 4- to 5-y follow-up visit, older adults with worsened MNA-SF nutritional status (from normal nutrition to at risk of malnutrition/malnourished) had the highest mortality (76.6 deaths per 1000 person-years; HR, 4.76; 95% CI, 2.82–8.03) compared with
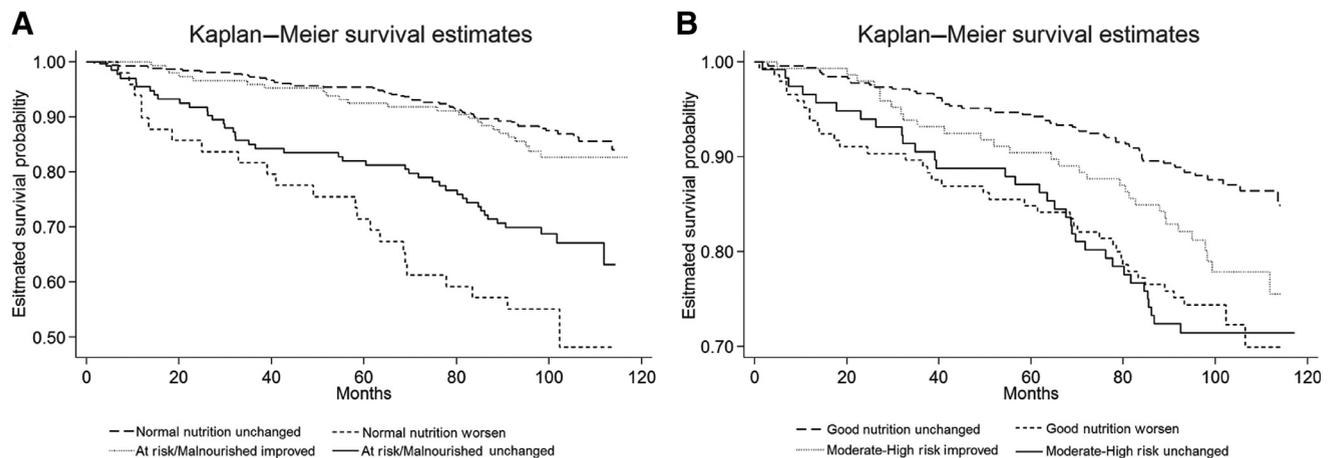
Fig. 2. Kaplan−Meier survival curve of older adults according to nutritional status transitions. (**A**) The 10-y survival curve according to the 4- to 5-y MNA-SF nutritional status transitions (N = 833; $P < 0.001$). (**B**) The 10-y survival curve according to the 4- to 5-y NSI nutritional status transitions (N = 860; $P < 0.001$).

the lowest mortality rate (16.2 per 1000 person-years) among those who maintained MNA-SF normal nutrition throughout the 10-y period. Those with unchanged MNA-SF at risk of malnutrition/malnourished status also had significantly increased rate of mortality (46 per 1000 person-years; HR, 2.57; 95% CI, 1.59−4.15). As well, those whose MNA-SF status improved at the 4-to 5-y follow-up from being at risk of malnutrition/malnourished at baseline showed lower rates of mortality (20.7 per 1000 person-years) than those with persistent at-risk of malnutrition/malnourished status (HR, 0.43; 95% CI, 0.23−0.80).

According to NSI nutritional risk status transitions, similar significantly higher mortality rates were associated with status deterioration from good nutrition to moderate/high nutritional risk (37.9 per 1000 person-years; HR, 1.99; 95% CI, 1.27−3.14) and persistent moderate/high nutritional risk (39.2 per 1000 person-years; HR, 1.97; 95% CI, 1.17−3.32), compared with those who maintained good nutrition (16.1 per 1000 person-years). As well, those with improved NSI nutritional status from moderate/high nutritional risk to good nutrition had lower rate of mortality (27.5 per 1000 person-years) compared with those with persistent moderate/high nutritional risk (HR, 0.59; 95% CI, 0.31−1.10).

Discussion

To our knowledge, this is the first study to describe long-term changes in nutritional status (deterioration or improvement) among a typical older age group of men and women in the community and shows their long-term associations on functional well-being and mortality. The literature search uncovered only one previous study (the Manitoba Follow-up Study) [14] of an atypical small cohort (N = 336) of very old (average age 90 y) men that described different nutritional risk trajectories over a 4-y period. Poor nutritional risk trajectories were associated with up to two times higher risk for mortality over a short (2.5 y) period of time thereafter. No other studies have investigated how various patterns of long-term changes in nutritional status are associated with subsequently different functional and mortality outcomes.

It is widely recognized that typically about one in four older people in the community are either at risk of malnutrition or malnourished [21,27], and the likelihood of poor nutrition increases with advancing age. However, there is scarce longitudinal data of estimates of the risk patterns of becoming malnourished or

nutritional deterioration over many years. Interestingly, in our longitudinal study, poor nutrition in some older persons actually improved over time. These observed changes in nutritional status appear to be spontaneous, and are perhaps not surprising. The reasons for the appearance or aggravation of malnutrition are not investigated in this study, but could in part be due to advancing age, increasing morbidity, and deteriorating social circumstances predisposing or precipitating the occurrence of malnutrition. Conversely, favorable alterations in exposures to protective factors may account for improved nutrition in some individuals.

Furthermore, we found that the onset and persistence of poor nutrition were associated with worse functional and mortality outcomes. Individuals who became poorly nourished or were persistently in poor nutrition were more likely to experience worse functional well-being and die prematurely than their counterparts who maintained good nutrition. Conversely, we found that individuals who showed improved nutrition appeared to have lower risks for adverse functional and mortality outcomes than those who maintained poor nutrition, although not all the results were statistically significant.

There is no unified definition and no ideally accurate measurement tool for malnutrition [28]. The MNA is the most widely used instrument for screening and assessing nutritional status, and the MNA-SF used in this study has been shown to predict 4-y mortality in elderly Chinese as well as the full MNA. [29] We complemented the use of the MNA-SF with the NSI because the NSI is useful not only as a screening tool but also as an educational tool for promoting elderly nutritional well-being in the community setting [19]. Of the 10 items in the NSI, 7 were questions related to economic difficulty, social isolation, tooth loss/mouth pain, and impaired functional ability contributing to reduced quantity and quality of food intake, compared with only 1 of the 6 items in the MNA-SF (or 6 of the 18 items in the full MNA). [30] Also, 66% of the full MNA items are associated with physical, psychological, and cognitive functional impairment related to chronic diseases and frailty. Non-nutritional attributional bias may inflate estimates of the association of MNA nutritional status with functional and mortality outcomes. The NSI estimates were found to be robust and corroborated those from MNA-SF (NSI and MNA-SF had similar areas under the curve for functional and mortality outcomes; data not shown), but furthermore appeared to be more sensitive in demonstrating a lower OR of association (OR, 0.17;

95% CI, 0.05−0.59) between improved nutrition (from moderate/ high nutritional risk to good nutrition) and subsequent IADL or ADL disability.

Some other study limitations should be noted. There were selectively greater losses to follow-ups among study participants with relatively poorer nutritional and health status at baseline. Participants who became functionally disabled during the course of follow-ups were more likely to die earlier, and attrition cases of IADL or ADL functional disability were unaccounted in the analyses. This likely results in underestimates of the strengths of associations between nutritional status changes and subsequent incident functional disability. Mortality case ascertainment from national computerized search was complete and highly accurate, hence estimates of mortality risks associated with nutritional status changes were reliable.

Taken together, these observations clearly indicate that nutritional health among older individuals in the community show notable variations in levels over time and have significant associations with functional well-being and mortality. This has important implications for health and social service planning and provisions. Malnutrition is a major contributor to the global burden of disease. [31] There were >20 million cases of protein-energy malnutrition in 2013, normally a result of severe food insecurity, which is well documented among children, but is probably underestimated among older people. Apart from selected high-risk groups of hospitalized patients with end-stage renal diseases, cancers, chronic heart and lung diseases, and other diseases, far larger numbers of older persons in the community and primary care are at risk of malnutrition or are malnourished. The screening, diagnosis, and treatment of malnutrition and nutritional education and support to promote better nutrition in the populace should be undertaken in the broader primary health care and social service setting. The approach of nutritional risk monitoring using simple screening tools can help older men and women at high risk for adverse functional and mortality outcomes to be identified for selective nutritional interventions. This could potentially generate large returns on investment in terms of reduced functional disability, health care and long-term care costs, mortality, and improved autonomy and QoL.

Conclusion

Changes in nutritional status are associated with adverse health outcomes and should be monitored with simple screening tools to identify older adults at high risk for adverse functional and mortality outcomes for selective nutritional interventions.

Acknowledgments

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi: 10.1016/j.nut.2019.05.006.

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