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Prevalence and Risk Factors of Undernutrition among Older Adults Living in Nonsubsidized Residential Care Homes: A Cross-sectional Descriptive Study

Cheung, Daphne Sze Ki[1] · Wang, Shanshan[2] · Cheung, Franco Tsz Fung[3] · Ho, Ken Hok Man[4] · Liu, Justina Yat Wa[5] · Cheng, Hui-Lin[6] · Lam, Simon Ching[7]

[1]Associate Professor, School of Nursing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR
[2]Research Assistant Professor, School of Nursing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR
[3]Research Assistant, School of Nursing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR
[4]Assistant Professor, The Nethersole School of Nursing, The Chinese University of Hong Kong, Hong Kong SAR
[5]Associate Professor, School of Nursing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR
[6]Assistant Professor, School of Nursing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR
[7]Associate Dean (Research) & Professor, Centre Director of Integrative Health Centre, School of Nursing, Tung Wah College, HoManTin, Kowloon, Hong Kong SAR

Purpose: This study investigated the prevalence and risk factors of undernutrition among older adults living in nonsubsidized Residential Care Homes (RCHs). **Methods:** Face-to-face interviews and assessments were conducted in a convenience sample of 298 older adults (aged 65 years or older) residing in nonsubsidized RCHs in Hong Kong in January 2015. Subjects who ate by mouth (with or without assistance) and who had no communication barriers were included. We employed a descriptive cross-sectional study design according to the STROBE reporting guidelines. Data were collected on participants' demographics, history of chronic illness, physical function (assessed by the 10-item Simplified Barthel Index with the self-care ability and mobility subscales), cognitive function (assessed by the 10-item Abbreviated Mental Test), and nutritional status (assessed by the 18-item Mini Nutritional Assessment). After identifying the variables associated with undernutrition, hierarchical multivariate logistic regression was used to identify salient predictors. **Results:** In total, 40.9% of participants had undernutrition, which was associated with a longer length of stay in RCHs and poorer physical and cognitive functions compared to adequate nutrition or being at risk of undernutrition. Hierarchical multivariate logistic regression showed that residents with better cognitive function (adjusted Odds Ratio [OR]=0.88) and self-care ability (adjusted OR=0.75) were at a lower risk of undernutrition. **Conclusion:** Undernutrition is prevalent among residents in RCHs in Hong Kong and poses a significant risk of cognitive impairment and poor self-care skills. To lessen the likelihood and the consequences of undernutrition, RCHs must give special consideration to residents with these risk factors.

Key Words: Cognition; Malnutrition; Mobility limitation; Physical functioning; Self-care

INTRODUCTION

Undernutrition is a major health concern among older adults worldwide and is manifested in deficiencies of energy, protein, and other nutrients, which have measurable adverse effects on function and clinical outcomes [1]. Research has shown that undernutrition is more prominent in older adults living in Residential Care Homes (RCHs), with a prevalence of 12% to 29% internationally [2] and 22% in Hong Kong [3]. The consequences of undernutrition in older adults are devastating and can directly impair the immune system, including cell-mediated immunity, phagocyte function, and cytokine production with a subsequent increase in the risk of infection [4,5]. In addition, undernutrition in older adults is associated with falls, pressure injuries, bone embrittlement, psychological dete-

Corresponding author: Lam, Simon Ching https://orcid.org/0000-0002-2982-9192
Centre Director of Integrative Health Centre, School of Nursing, Tung Wah College, Rm 1601G, HoManTin, Kowloon, Hong Kong SAR.
Tel: +852-34686854, Fax: +852-27821566, E-mail: simlc@alumni.cuhk.net

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rioration, poor quality of life, and higher mortality [6]. More older adults are receiving residential care in Hong Kong than in most Western and Asian countries [7]. However, due to the long waitlist for subsidized RCHs, non-subsidized (i.e., self-financing) RCHs are the major service providers (63%) [8].

To cope with fiscal pressures, privatization of social services like residential care is also common in Europe, the U.S., and many larger cities and suburbs worldwide. Profit-making companies have more incentive than public or nonprofit organizations to reduce costs, which may lead to a decrease in the quality of services [9]. Lower staffing levels, higher turnover, and staff with less training can negatively impact the residents' nutritional status. Although the individualized care approach and the person-centered care concept were widely adopted in the 2000s [10], it is still unclear whether the highly individualized nutritional needs of residents with multi-morbidities have been adequately addressed in nonsubsidized RCHs.

In addition to the systemic conditions that contribute to undernutrition, it is also essential to identify the medical risk factors of undernutrition. The nutritional needs of residents with renal dysfunction, chronic pulmonary obstructive disease, diabetes, hypertension, cardiovascular disease, or gout are different [11-15] and require modifications of dietary or fluid intake. This is exemplified by the degree of diet restriction for patients with renal disease, which depends on the stage of the disease and whether there are comorbidities such as cardiovascular and metabolic problems; the dietary requirements can be immensely complex [16]. In a multicenter study of nursing homes, the staff's knowledge of how to meet the modified dietary needs of the residents was found to be limited [17]. A retrospective cohort study in a hospital in Taiwan indicated that lower cognitive function, limited self-care ability, and decreased mobility were commonly reported risk factors for undernutrition in geriatric patients [18]. However, comprehensive studies have yet to be conducted on whether residents with these risk factors who are under the care of healthcare professionals in RCHs are more prone to undernutrition.

Investigating the prevalence of undernutrition and identifying its possible risk factors is particularly important since it is associated with mortality among older adults living in RCHs and with higher healthcare expenditures [19]. To address the knowledge gaps, this study aimed to (1) provide up-to-date information on the prevalence of undernutrition in nonsubsidized RCHs and (2) examine the factors associated with undernutrition in residents. We hypothesized that comorbidities involving fluid/dietary restrictions, lower cognitive function, limited self-care ability, and decreased mobility would be significant risk factors for undernutrition.

METHODS

1. Study Design

This study was a cross-sectional study and was reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline (https://www.equator-network.org/).

2. Setting, Sample Size, and Samples

The study was conducted in nonsubsidized RCHs registered with the Social Welfare Department of the Hong Kong government in January 2015. The sample size was estimated according to the Cochran formula [20]. The estimated sample size was 300, with Z=1.96 for 95% confidence level, p=26.7% for the estimated prevalence of undernutrition, and e=5% for an acceptable margin of error. We assumed that one-third to one-fourth of the residents in a nonsubsidized RCH would be eligible (i.e., able to communicate and orally consume food) and would agree to join the study. Therefore, six homes would be needed to recruit enough participants. The homes were selected by simple randomization from the list of nonsubsidized RCHs in the Enhanced Bought Place Scheme category registered with the Social Welfare Department (total number of registered nonsubsidized RCHs=191 homes) [21].

Convenience sampling was employed. Participants included those living in the six randomly selected nonsubsidized RCHs that agreed to join this study and met the following inclusion criteria: (1) aged 65 years or above, (2) able to eat by mouth with/without assistance, and (3) able to communicate in Cantonese. No additional exclusion criteria were imposed for this study.

3. Ethical Considerations

Ethical approval for this study was obtained from the university (No: DEC-131205-12) and followed the Declaration of Helsinki. Participation in this study was voluntary, and no compensation was given to the nonsubsidized RCH residents, their caregivers, or the RCHs.

4. Measurements / Instruments

The risk factors of undernutrition that we examined

were physical function, cognitive function, comorbid diseases with dietary or fluid restrictions (i.e., renal dysfunction, gout, diabetes, hypertension, chronic obstructive pulmonary disease, and heart disease), and general demographics, as described below.

Nutritional status: The primary outcome of this study was nutritional status, assessed using the modified Chinese version of the Mini Nutritional Assessment (MNA), which consisted of 18 items with four domains (anthropometric measurements, dietary assessment, global health and social assessments, and subjective assessment of health and nutrition) [22-24]. The MNA is a comprehensive measurement of nutritional status. Although there are different versions of the MNA, all include Body Mass Index (BMI) as a key item, which is the most widely recognized measurement in nutrition screening [19]. BMI exhibits good sensitivity (84%) and specificity (79%) for undernutrition screening when compared with a variety of nutritional assessment parameters, such as biochemical values, dietary intakes, and others. [22]. A total MNA score < 18.5 (range 0~30) indicates a state of "undernutrition," 18.5~23.5 refers to a condition of being "at risk of undernutrition," while >23.5 is a sign of "adequate nourishment" [23]. This version has been tested among institutionalized older adults with satisfactory reliability [23], and the applicability has also been tested for Chinese geriatric patients in Hong Kong in 2005 [24].

Physical function: Physical function was assessed using the Simplified Barthel Index (SBI) [25,26]. The SBI consists of 10 questions: 6 on self-care abilities (SBI-SC) such as feeding, bathing, grooming, dressing, bowel control, and bladder control; and 4 on mobility (SBI-Mob) such as toileting, chair transfer, ambulation, and stair climbing. The total score ranges from 0 to 20, with a lower score indicating greater physical dependence. In Hong Kong, the SBI was found to show satisfactory reliability, validity, and diagnostic accuracy (sensitivity and specificity >.75; area under the curve, .83~.98) in residential care settings [26]. Based on the current data, the internal consistency of subscales SBI-SC and SBI-Mob was 0.90 and 0.86, respectively. The research assistant performed the SBI assessments and verified the scores with each participant's latest progress sheet (within 7 days, if applicable).

Cognitive function: The Abbreviated Mental Test (AMT) (Hong Kong version) was used to assess cognitive function [27]. The AMT consists of 10 questions with a nominal response format (i.e., yes/no) targeting orientation to time and place, attention, calculation, and memory. A higher score indicates better cognitive status, and the score ranges from 0 to 10. A previous study showed that the cutoff score for residents of RCHs is 7 for impaired cognition (with a sensitivity of 92.3% and a specificity of 87.1%) [27]. The AMT showed good reliability (Cronbach's α =.81) and validity (content validity index=.92; Pearson correlation with the Mini-Mental State Examination=.86; and construct validity between groups showed a significant differ <.001) when used among local older adults living in nursing homes [27].

General and clinical information: The comorbid diseases with a dietary or fluid restriction (i.e., renal dysfunction, gout, diabetes, hypertension, chronic obstructive pulmonary disease, and heart disease) were assessed by asking residents whether they had any of those medical conditions and reviewing the residents' profiles for verification. Information on sex, age, and duration of stay in the RCH was collected by reviewing each participant's progress sheet and/or profile.

5. Data Collection / Procedure

The average capacity of the participating homes listed in the Social Welfare Department was 150~200 beds. Six nonsubsidized RCHs were randomly selected, and all agreed to participate in the study and provide access. The inclusion criteria, information sheet, and consent form were sent to the selected nonsubsidized RCHs. The responsible staff of each respective nonsubsidized RCH asked for verbal consent from a prepared list of potential participants. There were 350 potentially eligible participants on the list. Accordingly, 350 invitation letters were sent to the residents or their proxies (if the participant was cognitively impaired), and 317 residents or their proxies replied with the consent forms and agreed to take part. Our research assistant approached each eligible participant, and 298 older residents were assessed and interviewed. Nineteen residents or their proxies declined the interview and assessment for various reasons, including deterioration of their physical and mental condition, relocating to another RCH, and unavailability (e.g., home leave, medical appointments). Each interview averaged 25 minutes. The response rate was 85.1% (298/350).

6. Data Analysis

SPSS version 23.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. The prevalence of undernutrition in nonsubsidized RCHs was calculated as percentage. Descriptive statistics were reported for demographic variables, medical conditions, and physical and cognitive functions. Comparisons of the mean or percentage of these vari-

ables were made between the normal group (i.e., adequate nutrition and at risk of undernutrition) and the undernutrition group. Mean comparisons were conducted using the Independent Sample t-test or the Kruskal-Wallis H test. Percentages were compared using the x^2 test.

Logistic regression with a hierarchical block design was used to identify the risk factors of undernutrition. The prerequisite step of regression was the multicollinearity check, which reported that the correlation among all continuous variables (involved in the regression model) was not too high. A tolerance greater than 0.1 and Variance Inflation Factor (VIF) values less than 10 were not regarded as violations of the multicollinearity assumption. The first step in the hierarchical logistic regression included the factors of sex, age, and duration of stay in the RCHs. The second step added medical conditions as reflected in the number of chronic illnesses and individual illnesses. The third step added physical function (separate SBI subscales: mobility and self-care ability) and cognitive function. The level of significance was set at $p < .05$ for all statistical analyses.

RESULTS

1. General and Clinical Characteristics

The participants had a mean age of 83.08 years (Standard Deviation, SD 7.80 years), and 40.9% were male (Table 1). The mean duration of stay in nonsubsidized RCHs was 37.72 months (SD 36.60 months). Slightly more than half of the participants suffered from hypertension, and approximately one-third had been diagnosed with dementia, diabetes mellitus, or heart disease (i.e., a range of conditions that affect the heart, such as coronary artery disease and arrhythmias). The mean AMT score was 4.18 (SD 3.17), and more than two-thirds of the participants were living with various levels of cognitive impairment (i.e., AMT score < 7). Regarding SBI sub-scores, the mean score for both mobility and self-care was approximately 5 (SD 3.03~3.32). The general and clinical demographics of the participants and detailed numerical data on the prevalence of disease among the participants are shown in Table 1. The nutritional status and physical and cognitive function of the participants are presented in Table 2.

2. Prevalence of Undernutrition

The mean MNA score was 18.59 (SD 4.29). Over 40.9% (n=122) of the participants were found to be in a condition of undernutrition (i.e., total score <18.5) (Table 2), and approximately half (n=146) were at risk of undernutrition (i.e., total score=18.50~23.50). Only 10.1% (n=30) were found to be adequately nourished (data not shown). To facilitate further multivariate analysis for identifying the salient predictors of undernutrition, the "at risk of undernutrition" and "adequately nourished" groups were combined for analysis.

3. Factors Related to Undernutrition

The significant differences that were found between the undernutrition and the at-risk/ adequate undernutrition groups were used as independent variables for the hier-

Table 1. Comparison of Nutrition Levels in Residents of Unsubsidized RCHs According to Demographic Characteristics and Medical Condition

Variables	All participants (n=298)	Adequate nutrition or at risk of undernutrition (n=176)	Undernutrition (n=122)	t-test *p*-value
	n (%) or M±SD	n (%) or M±SD	n (%) or M±SD	
Age (year)	83.08±7.80	83.26±7.18	82.81±8.64	.637
Duration of stay in RCH (month)	37.72±36.60	36.64±38.79	39.27±33.26	.543
Male	122 (40.9)	80 (45.5)	42 (34.4)	.057
Number of chronic illnesses	2.77±1.29	2.66±1.22	2.91±1.38	.097
COPD	21 (7.0)	10 (5.7)	11 (9.0)	.269
Heart disease	90 (30.2)	52 (29.5)	38 (31.1)	.767
Hypertension	163 (54.7)	97 (55.1)	66 (54.1)	.863
Diabetes mellitus	98 (32.9)	62 (35.2)	36 (29.5)	.301
Renal dysfunction	31 (10.4)	12 (6.8)	19 (15.5)	.015
Gout	28 (9.4)	14 (8.0)	14 (11.5)	.306

COPD=chronic obstructive pulmonary disease; M=mean; RCH=residential care home; SD=standard deviation.

archical multivariate logistic regression, with nutritional status as the dependent variable. Prior to the regression, the multicollinearity check indicated no assumption violation (Tolerance=0.35 to 0.99 and VIF=1.01 to 2.90). The combined groups of those at risk of undernutrition and those with adequate nutrition group were used as the reference group. Three models were generated: model 1 (adjusting for demographic characteristics), model 2 (adjusting for medical conditions on top of model 1), and model 3 (adjusting for physical and cognitive functions on top of model 2). In model 1, being male was shown to be associated with a significantly lower risk of undernutrition. In model 2, renal dysfunction was associated with a significantly higher risk of undernutrition, with males still showing a lower risk of undernutrition. In model 3, being male and suffering from renal dysfunction was no longer predictive of undernutrition. Better cognitive function (each 1-point score increment in the AMT would decrease the risk by 11.7%; p=.013) and self-care ability (each 1-point score increment in the SBI-SC would decrease the risk by 24.6%; p<.001) were preventive for undernutrition. Model 3 could explain 34.2% (Nagelkerke R^2) of the variance in nutritional status and correctly identify 73.8% of cases in this group of participants. Detailed results are shown in Table 3.

Table 2. The Nutritional Status and Physical and Cognitive Function of Residents in Unsubsidized RCHs

Variables	All participants (n=298)	Adequate nutrition or at risk of undernutrition (n=176)	Undernutrition (n=122)	p
	n (%) or M±SD	n (%) or M±SD	n (%) or M±SD	
Cognitive function, AMT score (0~10)	4.18±3.17	5.00±3.13	3.00±2.84	<.001
Cognitively impaired (AMT<7)	201 (67.4)	105 (59.7)	96 (78.7)	.001
Self-care ability, SBI-SC score (0~10)	4.95±3.32	6.22±3.06	3.11±2.79	<.001
Mobility, SBI-Mob score (0~10)	4.84±3.03	5.82±2.70	3.42±2.93	<.001
MNA score (0~30)	18.59±4.29	21.50±2.13	14.39±2.92	N/A

AMT=abbreviated mental test; M=mean; MNA=mini nutritional assessment; RCH=residential care home; SBI-Mob=Simplified Barthel Index-Mobility; SBI-SC=Simplified Barthel Index-Self-care ability; SD=standard deviation.

Table 3. Hierarchical Multivariate Logistic Regression Analysis of Undernutrition in Residents of Unsubsidized RCHs (*N*=298)

Variables	Categories	Model 1		Model 2		Model 3	
		Adj. OR (95% CI)	p	Adj. OR (95% CI)	p	Adj. OR (95% CI)	p
(Constant)		3.72	.338	6.31	.197	29.11	.041
Demographic characteristics	Age (year)	0.98 (0.95~1.01)	.251	0.97 (0.94~1.00)	.083	0.98 (0.94~1.02)	.261
	Male	0.58 (0.35~0.96)	.034	0.52 (0.31~0.88)	.014	0.57 (0.32~1.04)	.068
	Duration of stay in RCH (month)	1.00 (0.99~1.01)	.583	1.00 (0.99~1.01)	.646	1.00 (0.99~1.01)	.666
Medical condition	Number of chronic illnesses			1.22 (0.94~1.57)	.134	0.96 (0.18~1.29)	.798
	COPD			1.28 (0.49~3.32)	.618	1.33 (0.45~3.98)	.609
	Heart disease			0.92 (0.52~1.63)	.765	0.82 (0.42~1.54)	.548
	Hypertension			0.79 (0.46~1.37)	.399	1.28 (0.68~2.40)	.447
	Diabetics mellitus			0.72 (0.41~1.25)	.240	0.88 (0.46~1.70)	.706
	Renal dysfunction			2.37 (1.04~5.41)	.039	2.46 (0.97~6.22)	.058
	Gout			1.36 (0.59~3.17)	.473	2.24 (0.84~5.98)	.109
Physical and cognitive function	Cognitive function					0.88 (0.80~0.97)	.013
	Self-care ability					0.75 (0.66~0.87)	<.001
	Mobility					0.97 (0.84~1.13)	.704
Nagelkerke R^2		.02		.08		.34	

Adj. OR=Adjusted odds ratio; CI=confidence interval; COPD=chronic obstructive pulmonary disease; RCHs=residential care homes.

DISCUSSION

The results of this study indicate that undernutrition is highly prevalent among residents of nonsubsidized RCHs in Hong Kong. Alarmingly, when compared with the findings of a previous local study of government-subsidized RCHs (21.7%) [3], a significantly higher prevalence (40.9%) was found. However, the prevalence of undernutrition in this study is still within the scope of the global data range identified by Bell et al. (1.5% to 66.5%) [19]. Although the difference in prevalence between this study and the previous study conducted 18 years ago in government-subsidized RCHs in Hong Kong [3] could not be fully explained in this study, there is still a fundamental measurement difference that deserves discussion. The previous local study used a BMI <18.5 kg/m^2 as the only definition of undernutrition [3], while the present study used a modified version of the MNA to assess undernutrition. Since the MNA includes BMI and other essential parameters, using the MNA to define malnutrition instead of solely focusing on BMI was a better approach. The use of different criteria to assess undernutrition could be one reason why the present study showed a higher prevalence of undernutrition. Our study addressed the limitations of using BMI as the main indicator of undernutrition, as did a previous study that showed BMI to be a less desirable marker in older adults, especially those with sarcopenia [28]. A recent study noted that different versions of the MNA (which include BMI as a key item) were the most typically used and recognized measurements for nutrition screening [19].

1. Salient Predictors of Undernutrition

Good nutritional status is a significant protective factor against frailty [29], which warrants immediate attention from healthcare providers. The hierarchical multivariate logistic regression analysis in this study indicated that cognitive function and self-care ability were predictive of undernutrition. The predictive power of cognitive function for undernutrition was found to be consistent with existing evidence [2,30]. People with mild cognitive impairment or lower cognitive function may not remember whether they have finished a meal. People with lower cognitive ability might not communicate with staff that they need extra food when hungry. Systematic reviews have also shown that impairment in cognition leads to poor self-care, particularly in adults with heart failure and diabetes [31,32]. In RCHs with adequate staff, these older residents might be fed by staff at the appropriate time and given the appropriate amount of food. In RCHs with insufficient staffing [3], people with lower cognitive function might not express feelings of being hungry [31,32] and might be ignored by staff, thus being at a higher risk of undernutrition.

Poor physical function was also associated with the prevalence of undernutrition, which is consistent with previous studies [3,33]. The findings of this study are noteworthy because the results clearly delineated that self-care ability, but not mobility, could predict undernutrition. Older adults with lower self-care ability might not be able to feed themselves. These residents would have insufficient oral intake and hence be at risk of undernutrition. This result is important because it implies that RCH residents who cannot feed themselves (i.e., have lower self-care ability) are more likely to be malnourished. Many older adults with lower cognitive ability showed reduced self-care ability as well, as these two factors are closely related. In RCHs, mobility was less important regarding nutritional status, as meals were provided to residents at their bedside or they were assisted to dining tables. RCH staff must consider a routine nutritional assessment for these high-risk older residents (i.e., those with low self-care ability and impaired cognition). Furthermore, implementing routine physical and cognitive training and/or activities is recommended in RCHs (e.g., brisk walking and square dancing, music- with-movement [34,35], or more conventional activities like tai chi and mahjong [36,37]).

2. Renal Dysfunction and Undernutrition

It was noteworthy in model 2 that, of the comorbidities with relevant dietary or fluid restrictions, only renal dysfunction was identified as a statistically significant predictor. The association between renal dysfunction and undernutrition is consistent with the findings in a previous study conducted in a clinical setting [38]. Strict dietary restrictions (restrictions on protein, sodium, potassium, phosphorus, and fluid intake) [39], unpalatable controlled diets (especially in RCHs), the side effects of medications in patients with polypharmacy, and altered metabolism (including increased oxidative stress and protein catabolism) were found to be contributors to undernutrition in people with renal dysfunction [40]. Specific interventions can be implemented to target these contributors. This is an important issue, as undernutrition in renal dysfunction is associated with poor outcomes and a higher mortality rate [41]. Nevertheless, in model 3 of this study, the contributing power of renal dysfunction was reduced and no longer significant to undernutrition.

3. Strengths and Limitations

This is one of the few studies conducted to assess the prevalence of undernutrition among older residents of nonsubsidized RCHs and to provide valuable information on the prevalence of undernutrition among the RCHs in Hong Kong. This study delineated the salient factors of undernutrition, generating data that can be used to design specific interventions or assessment schemes for older residents with these risk factors. The prescription of nutritional supplements and routine nutrition assessments specific to residents with poor cognition and weak self-care ability are examples of such interventions.

Despite the strengths of this study, there were also some limitations. First, all RCHs that took part in this study were nonsubsidized "RA1" RCHs, indicating that they comply with the government's definition of a higher level of staffing [42]. Therefore, the result might not be generalizable to all nonsubsidized RCHs in Hong Kong. However, it is anticipated that the remaining nonsubsidized RCHs (i.e., those with staffing lower than the RA1 standard) may have more cases of undernutrition. Second, since nutritional status was assessed through interviews with the participants, recall bias cannot be eliminated, especially in those with cognitive impairment. We suggest conducting biochemical and physical examinations (e.g., serum albumin and C-reactive protein levels, hand grip strength) to obtain objective parameters that can cross-validate nutritional status in future studies. Third, although it is known that poor oral intake is associated with undernutrition [30], the actual oral intake of the participants was not assessed in this study.

CONCLUSION

Undernutrition was found to be highly prevalent (40.9%) among residents of private RCHs in Hong Kong. The presence of poor cognitive function and poor self-care ability were significant risk factors for undernutrition. Special attention should be paid to RCH residents with these risk factors to minimize the risk of undernutrition and its related consequences. Specific interventions and routine assessments targeting these subjects should be designed.

CONFLICTS OF INTEREST

Simon Ching Lam has been the Editorial board member of the Korean Journal of Adult Nursing since 2018. He was not involved the review process. Otherwise, no potential conflict of interest relevant to this article was reported.

The authors declare no conflict of interest to disclose regarding the publication of this article.

AUTHORSHIP

Study conception and design acquisition - LSC; Data collection - LSC; Analysis and interpretation of the data - LSC, WS and CDSK; Drafting and critical revision of the manuscript - CDSK, WS, CFTF, HKHM, LJYW, CHL and LSC.

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