Original Article

Prevalence and risk for malnutrition in older Thai people: A systematic review and meta-analysis

Mallika Chuansangeam MD[1], Chanya Wuthikraikun MD[1], Orawan Supapueng PhD[2], Weerasak Muangpaisan MD[3]

[1]*Division of Geriatric Medicine, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*
[2]*Division of Clinical Epidemiology, Department of Research and Development, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*
[3]*Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*

Background and Objectives: Malnutrition is potentially preventable in older people, but with varied reported prevalence. We assessed its prevalence, assessment methods, and risk factors in older Thai people. **Methods and Study Design:** Studies published from January 1, 2000, to September 30, 2020 were searched in Medline, EMBASE, Google Scholar, and local databases. A random-effects model was used to calculate pooled prevalence with subgroups analysis (setting of the patient, region). Forest plots displayed sensitivity and specificity for all nutritional screening tools validated against Mini Nutritional Assessment (MNA) with tests for heterogeneity. Publication bias was tested by funnel plot and Egger's test. **Results:** 71 studies (total 23,788 subjects) were included where mean age was 65.5 to 78.3 years. The pooled prevalences of malnutrition were 10.4%, 6.1%, and 5.7% by body mass index (BMI), MNA, and MNA-Short Form (MNA-SF), respectively. At-risk of malnutrition prevalence was 42.6% using the MNA and 37.8% using the MNA-SF. The pooled prevalence of malnutrition by BMI <18.5 kg/m^2 was 10.4% (95% CI 8.7-12.4). The pooled prevalence of malnutrition based on MNA was 6.1% (95% CI 3.8-9.4). It was highest among hospitalized patients and lowest in community-dwelling elders by both measures. Factors associated with malnutrition were female sex, advanced age, low education, living alone, living in rural areas, comorbidities, eating problems, and geriatric conditions. **Conclusions:** The pooled prevalence of elder malnutrition was 6-10%, depending on assessment method and study setting. Hospitalized older people were at increased risk of malnutrition. It might be ameliorated through community directed food systems.

Key Words: malnutrition, prevalence, Thai, older people

INTRODUCTION

The number of older people worldwide is increasing. The World Health Organization estimates that by 2025 the number of people aged 60 years and above will reach 1.2 billion and approximately 840 million will live in low-income countries.[1] Many comorbidities and conditions that lead to loss of physical and mental capacity are more common among older people, increasing care support needs. The overarching public health goal is to promote a healthy aging society with less dependency.

Nutrition is a key consideration for health. Malnutrition in older adults impairs the immune system,[2] increases disease severity and complication rates, increases the likelihood of falls, reduces physical function, reduces quality of life, prolongs hospital stays, increases the costs of health care, and increase mortality.[3-7] Risk factors of malnutrition in older people encompass 1) physiological factors including age, anorexia in aging, frailty, polypharmacy, chronic illness, alcohol use, decreased physical function, poor oral health, swallowing problems, dementia, Parkinson's disease, and the inability to do shopping or meal preparation and feed themselves; 2) psychological factors including loneliness, depression, and anxiety; 3) socioeconomic factors such as the location of residence, poverty, and education level.[8] However, malnutrition is both preventable and correctable, and its severity may be decreased if treated promptly.

Nutritional screening is a procedure used to find those who are malnourished or at risk of malnutrition to determine if a detailed nutritional assessment is indicated. Therefore, the evaluating tool should be easy to use and appropriate for implementation by all healthcare professionals.[9] According to a 2014 systematic review,[10] at least 33 different evaluating tools are available. The most common tools currently used in older people include, 1)

Corresponding Author: Prof Weerasak Muangpaisan, Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.
Tel: +6624197287
Email: drweerasak@gmail.com
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Mini Nutritional Assessment short-form (MNA-SF),[11] a validated screening tool for all settings; 2) Short Nutritional Assessment Questionnaire (SNAQ),[12] an easy screening tool to predict weight loss at six months in community-dwelling and long-term care residents; 3) The Nutritional Risk Screening (NRS-2002)[13] a recommended tool for hospitalized patient; 4) Malnutrition Universal Screening Tool (MUST),[14] which is recommended by ESPEN to be used at a community level;[15] 5) Malnutrition Screening Tool (MST) which is comprised of two questions addressing recent unintentional weight loss and poor appetite, and was validated in acute hospital and ambulatory care.[16] Although many screening tools are available, there is no universally-accepted single objective measure or gold standard to determine nutritional status.[17]

Following screening, a nutritional assessment can determine the presence of specific problems. Commonly used tools include the Mini Nutritional Assessment (MNA)[18] which can be used in hospital, community and long-term care settings, and the Subjective Global Assessment (SGA)[19] which is used to confirm malnutrition. Other methods to ascertain malnutrition status include assessment of dietary and medication intake, anthropometric measurement such as body mass index (BMI), subcutaneous fat thickness and body composition measurement, and biochemical markers such as serum albumin, cholesterol, white blood cell count, or anemia. Body composition assessment is sometimes used to confirm the altered body composition from malnutrition. Then, the treatable causes of weight loss should be sought and managed.

The prevalence of malnutrition in older people varies in different countries.[20] One reason for this is that previously there was no gold standard definition of malnutrition, although the common international consensus is that malnutrition is an inadequate nutritional status associated with adverse clinical outcomes. The global leadership initiative on malnutrition (GLIM) criteria were proposed in 2019 as such diagnostic criteria.[21] A two-step model for risk screening and diagnosis of malnutrition was proposed. The first step is to screen for "at-risk" status using any validated screening tool and the second step is the assessment using phenotypic and etiologic criteria including unintentional weight loss, low BMI, and decreased muscle mass. However, one of the phenotypic criteria in the GLIM-2019 is decreased muscle mass, which might hinder an epidemiologic study in many settings where the access to the measurement of muscle mass is limited. Other reasons for the varied prevalence were different screening tools used and different population characteristics. Some studies have used a BMI cut-off to define malnutrition.[22] In Thailand, the reported prevalence of malnutrition among Thai older people has ranged from 0 to 84.7%.[23-93] However, the screening and assessment methods used in these studies were different and this may have contributed to the wide variation in reported prevalence. Therefore, we conducted a systematic review and meta-analysis of malnutrition status in older Thai people.

Objectives

The primary objective was to assess the prevalence of malnutrition in Thai people aged 60 years and older. The secondary objectives were to evaluate methods for screening and assessing malnutrition and to study the risk factors of malnutrition.

METHODS

The protocol followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram.[94] To avoid bias in the selection process, the search strategy and selection criteria were defined a priori. Studies that conformed to the following criteria were investigated.

Search strategy

A systematic search was performed by MC and the articles identified through electronic searches of the international databases (Medline, EMBASE, and Google Scholar) and local databases (Thai Index Medicus, Thai Medical Index, Thai LIS, and Thai Journal Citation Index). The time frame for the search was from January 1, 2000, to September 30, 2020. The language was not restricted in the search strategy. Gray literature (e.g., thesis and conference papers) was also included. The search strategy combined the terms "malnutrition" OR "malnourished" OR "nutritional status" OR "undernutrition" OR "nutrition disorders" OR "nutrition surveys" OR "nutrition assessment" AND "elderly" OR "old" OR "older" OR "aged" OR "aging" (both in English and Thai language). In addition, a manual search was performed for potentially relevant studies using existing references cited in selected articles.

Inclusion criteria and exclusion criteria

Studies were included if they reported the prevalence of malnutrition in older Thai people (≥60 years) with a minimum sample size of 30, and measured malnutrition by using standardized and validated measuring tools (questionnaire, anthropometric, or biological indices). Studies were excluded if they included patients with terminal disease or had used duplicated data.

Selection of studies

Initial search results were saved in the EndNote program. After deleting duplicate studies, two researchers (MC and CW) independently selected research papers using titles and abstracts based on the inclusion and exclusion criteria. Then, MC and CW separately reviewed the individual articles to make a final determination whether to include or discard the study. Any disagreement was discussed between the two researchers, and disagreements were resolved by WM.

Data extraction and management

MC and CW independently extracted data using a data extraction form. The form included authors, title, year of study, study design, place, setting, population characteristics, sample size, assessment methods, prevalence, and associated factors (Supplementary table 1).

Assessment of the quality of the published studies

The quality assessment and risk of bias of the included studies were assessed by MC and CW and any disagree-

Table 1. Selected studies on factors associated with malnutrition or at-risk of malnutrition in older Thai people

Author, year	Population	Method	Factors
Arsasoi K, 2013[23]	CD	BMI MNA	Less than 20 teeth OR=2.08 (95% CI=1.06-4.09) (p=0.032) Female OR=2.04 (95% CI=1.06-3.91) (p=0.032) Age of 70 years or more OR=2.75 (95% CI=1.43-5.28) (p=0.002)
Boontanon N, 2017[27]	CD	BMI MNA-SF	Age (p<0.001) Rural area (p=0.001)
Chalermsri C, 2018[29]	OP	MNA	IADL dependence OR 5.3 (95% CI=3.1-9.2) BADL dependence OR 3.6 (95% CI=2.2-6.0) Dementia OR 3.9 (95% CI=2.4-6.3) Depression OR 3.4 (95% CI=2.0-5.7) Education level (<4 years) OR 2.2 (95% CI=1.4-3.4) Cerebrovascular disease OR 2.2 (95% CI=1.2-4.1) Medication (>5 items) OR 1.9 (95% CI=1.1-3.1) Female OR 1.8 (95% CI=1.2-2.9) CCI, (each score) OR 1.4 (95% CI=1.2-1.7) Age, (years) OR 1.1 (95% CI=1.0-1.1)
Chinuntuya P, 2016[32]	IP	MST Albumin	Risk of malnutrition Length of hospital stay rs =0.46 (p<0.01) Malnutrition Length of hospital stay rs=0.35 (p<0.01)
Churak P, 2018[33]	CD	BMI	Age ≥70 years OR=5.5 (95% CI=2.3-13.0) Single OR=12.9 (95% CI=2.4-69.5) Widow/Divorce/Separation OR=3.5 (95% CI=1.5-8.2) Teeth or gum diseases OR=8.0 (95% CI=2.2-28.9) Appetite disorder OR=3.0 (95% CI=1.4-6.5)
Gaewkhiew P, 2019[36]	CD	BMI	Functional dentition PR: 0.39 (95% CI=0.16-0.95)
Kanin M, 2020[40]	OP	BMI MNA	Exercise β 0.241 (p<0.001) ADL β 0.232 (p<0.001) Underlying disease β -0.162 (p=0.004) Age β -0.140 (p=0.015) Have related people in family β 0.114 (p=0.036)
Khanrugsa S, 2017[41]	IP	NRS 2002	Depression OR 1.191 (95%CI=1.059-1.034) Length of stay OR 1.166 (95%CI=1.019-1.334) Age OR 1.170 (95%CI=1.081-1.260)
Limpawattana P, 2020[46]	OP	BMI	Depression OR 13.2 (95% CI=2.37-73.66) (p=0.003)
Samnieng P, 2011[67]	CD	MNA	Number of teeth present, number of decayed teeth, number of FTUs, chewing ability test score (p<0.05)
Srisilapanan P, 2002[76]	CD	BMI	19 or less natural teeth OR 2.42 (95% CI=1.64-3.60) (p<0.001) no natural teeth OR 2.84 (95% CI=1.67-4.85) (p<0.001)
Sriwichian T, 2016[78]	CD	BMI MNA MNA-SF	Depression Coefficients SE (b, beta) -0.22 and -0.37 p<0.001 ADL (b, beta) 0.28 and 0.32 (p=0.01)
Tubtimtong P, 2019[88]	CD	BMI MNA-SF	Female (p<0.0001) Lower education (p=0.03) Living with family (p=0.02) Comorbidities (p=0.037) Mouth dryness (p=0.002) Avoidance of eating vegetables and fruits (p=0.032) Periodontal pockets (p=0.03) Number of natural teeth (≥20 and < 20 teeth) (p=0.003) Number of functional units (≥10 FUs and <10 FUs) (p=0.029) Type of functional units (natural maxillary teeth occluding with natural mandibular teeth) (p=0.008)
Wanaratna K, 2019[89]	CD	MNA-SF	Frailty OR 2.50 (95% CI=1.23-5.09)

CD: community dwelling; OP: out-patient; IP: in-patient; BMI: Body mass index; MNA: Mini nutritional assessment; MNA-SF: Mini nutritional assessment short form; MST: Malnutrition screening tool; ADL: activity of daily living; IADL: instrumental ADL; BADL: basic ADL; CCI: Charlson comorbidities index; OR: Odd ratio; PR: Poisson regression; β: Standardized regression coefficient beta.

ment was discussed with WM. The researchers used a 10-item rating tool developed by Hoy et al.[95] The result of the risk of bias and quality assessment is presented in Supplementary table 1.

Statistical analysis for the meta-analysis

RStudio version 1.4.1193 software was used to calculate a pooled estimate of prevalence and subgroups analysis (setting of the patient, region). Forest plots were used to

display sensitivity and specificity for all nutritional screening tools validated against MNA.

We assessed heterogeneity among studies using forest plot, I-square (I2) test, and Cochran Q test. Four intervals of I^2 were used: less than or equal to 25% represents insignificant heterogeneity; 26-50% represents low heterogeneity; 51-75% represents moderate heterogeneity; and more than 75% represents high heterogeneity. We used a random-effects model to conduct the meta-analyses.

Finally, we checked for the presence of publication bias by funnel plot and Egger's test using RStudio software.

RESULTS

Study selection

The search yielded 5,086 citations, including 1,060 duplicates. Four articles were identified from checking the reference list of relevant articles and review articles for malnutrition in the Thai older people. After title, abstract, and full-text screening, 3,959 articles were excluded, resulting in 71 relevant articles that were included in this systematic review (Supplementary figure 1).

Study characteristics

Data from 71 studies were included and analyzed to obtain the pooled prevalence of malnutrition. Sixty-seven were cross-sectional studies, and four were prospective cohort studies. Fifty-one studies were conducted in a community setting, nine in hospitalized settings (cancer patients in three studies), 10 in an outpatient setting (four of which were geriatric clinics), and a single study in a nursing home for older adults. Eighteen studies were conducted in the Bangkok metropolitan region, five from the central region of the country, 20 from the northeast, 18 from northern region, three from the southern region, four from the western region, and three were national. In total, 23,788 subjects were included with the least sample size of 30 and the highest of 4753 (Supplementary table 1).

There was a low risk of bias for 32 studies, moderate risk of bias for 29 studies, high risk of bias for 9 studies, and one study could not be evaluated due to incomplete data.

The most often used method of malnutrition assessment was anthropometric measurement. Fifty-three studies used BMI, 51 of which used a cut-off value below 18.5 kg/m^2, and two studies used a cut-off below 20 kg/m^2 to indicate malnutrition. Other studies measured skinfold thickness (two studies), mid-arm circumference (two studies), and calf circumference (one study). The MNA was used in 19 studies, MNA-SF in three studies, the SGA in nine studies, and the Nutrition Alert Form (NAF) in one study. In addition, biochemical data were used to assess malnutrition, including serum albumin (six studies), total lymphocyte count (one study), hemoglobin (three studies), hematocrit (three studies), and cholesterol (one study). For nutrition risk screening, 11 studies used MNA-SF, 22 studies used the MNA, two studies used the MST, two studies used the Nutrition Risk Classification (NRC), and three studies used the Nutritional Risk Screening (NRS).

Prevalence of malnutrition by BMI

The pooled prevalence of malnutrition by BMI <18.5 kg/m^2 was 10.4% (95% CI 8.7-12.4) (Figure 1). The highest prevalence was among hospitalized patients (16.3%, 95% CI 8-30). The lowest prevalence was estimated in community-dwelling elders (9.8%, 95% CI 7.9-11.9). (Figure 1) Regionally, the highest prevalence was 14.9% (95% CI 8.5-25.0) in the north and the lowest prevalence was 6.1% (95% CI 4.5-8.2) in the Bangkok metropolitan region (Supplement figure 2). There was high heterogeneity among studies (I^2=93%, p<0.01). We performed sensitivity analysis by excluding studies with a high risk of bias (four studies) and studies with less than 100 subjects (17 studies). After the exclusion, we found that pooled prevalence was 8.3% (95%CI, 6.6-10.4%) with significantly high heterogeneity among studies (I^2=94%, p<0.01) (Supplementary figure 3).

Prevalence of malnutrition by MNA

The pooled prevalence of malnutrition based on MNA was 6.1% (95% CI 3.8-9.4) (Figure 2). The prevalence was highest in the inpatient setting (21.1%; 95% CI 16.1-27.1) and lowest in the community setting (5.6%; 95% CI 3-10.3). None of the studies had a high risk of bias. The highest prevalence was among studies in the Northern region (11.2%; 95% CI 3.6-29.9). There was significantly high heterogeneity among studies (I^2=96%, p<0.01). After we performed sensitivity analysis by excluding subject numbers below 100, the pooled prevalence was 5.3% (95% CI 3.4-8.4) (Supplementary figure 4).

Prevalence of malnutrition by MNA-SF

The pooled prevalence of malnutrition based on MNA-SF was 5.7% (95% CI 4-8.1) (Supplementary figure 5). Three studies were too small to test for heterogeneity.

Prevalence of malnutrition by other assessment tools

Because there were insufficient studies using other tools, we were unable to perform a meta-analysis of the prevalence of malnutrition by those methods. The prevalence of malnutrition assessed by skinfold thickness was 32.9% in community settings and 57.6% in outpatient settings, by mid-arm circumference was 3.1% in community settings, and 61.0% in outpatient settings, and by calf circumference was 30.2% in community settings. By nutrition assessment tool, the prevalence of malnutrition by SGA was 39.1% in the hospitalized setting.

In studies that used biochemical data to assess malnutrition, the prevalence of low albumin was 0% in a community setting, 19.8% in an outpatient setting, and 23.6-85.9% in the hospitalized setting. When assessed by a total lymphocyte count below 1500, the prevalence was 56.4% in the hospitalized setting. By definition of low hemoglobin, there were 33.6%-80.9% in hospitalized setting and 74.2% (from one study) in an outpatient setting, similar to low hematocrit [33.9-81.8% and 73.6% (from one study) in hospitalized and outpatient, respectively]. One study defined cholesterol below 160 mg/dL as malnutrition and reported the prevalence to be 39.8% in hospitalized patients.

Prevalence of at-risk of malnutrition by MNA

The pooled prevalence of at-risk of malnutrition based on MNA is 42.6% (95% CI 36-49.4). (Supplementary figure

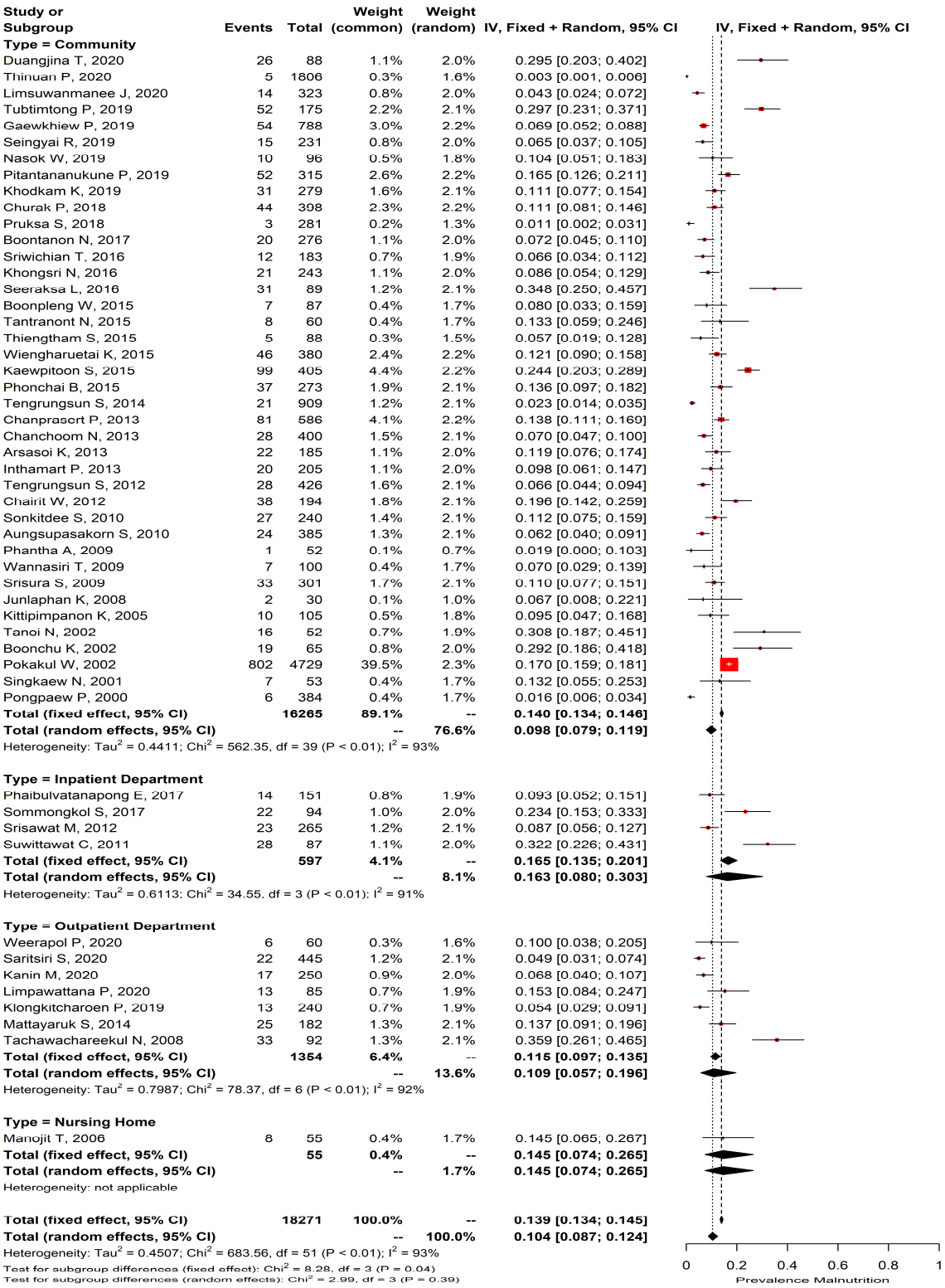

Figure 1. Forest plot of studies of malnutrition in Thai older people by BMI.

6) There was significantly high heterogeneity among studies (I^2=97%, p<0.01). After excluding studies with fewer than 100 subjects, the prevalence was 41.0% (95% CI 34-48.4) (Supplementary figure 7).

Prevalence of at-risk of malnutrition by MNA-SF

The pooled prevalence of at-risk of malnutrition based on MNA-SF was 37.8% (95% CI 32.1-44.0) with significantly high heterogeneity among studies (I^2=92%, p<0.01) (Supplementary figure 8). After excluding studies with fewer than 100 subjects, the prevalence was 35.5% (95% CI 30.3-41.1) (Supplementary figure 9).

Prevalence of at-risk of malnutrition by other assessment tools

Because there were insufficient studies, we were unable to perform a meta-analysis of the prevalence of at-risk of malnutrition. The prevalence was 32.6%-54.3% by MST, 46.3-76.2% by NRC, and 53.1%-92.5% by NRS. All of these studies were done in the hospitalized setting.

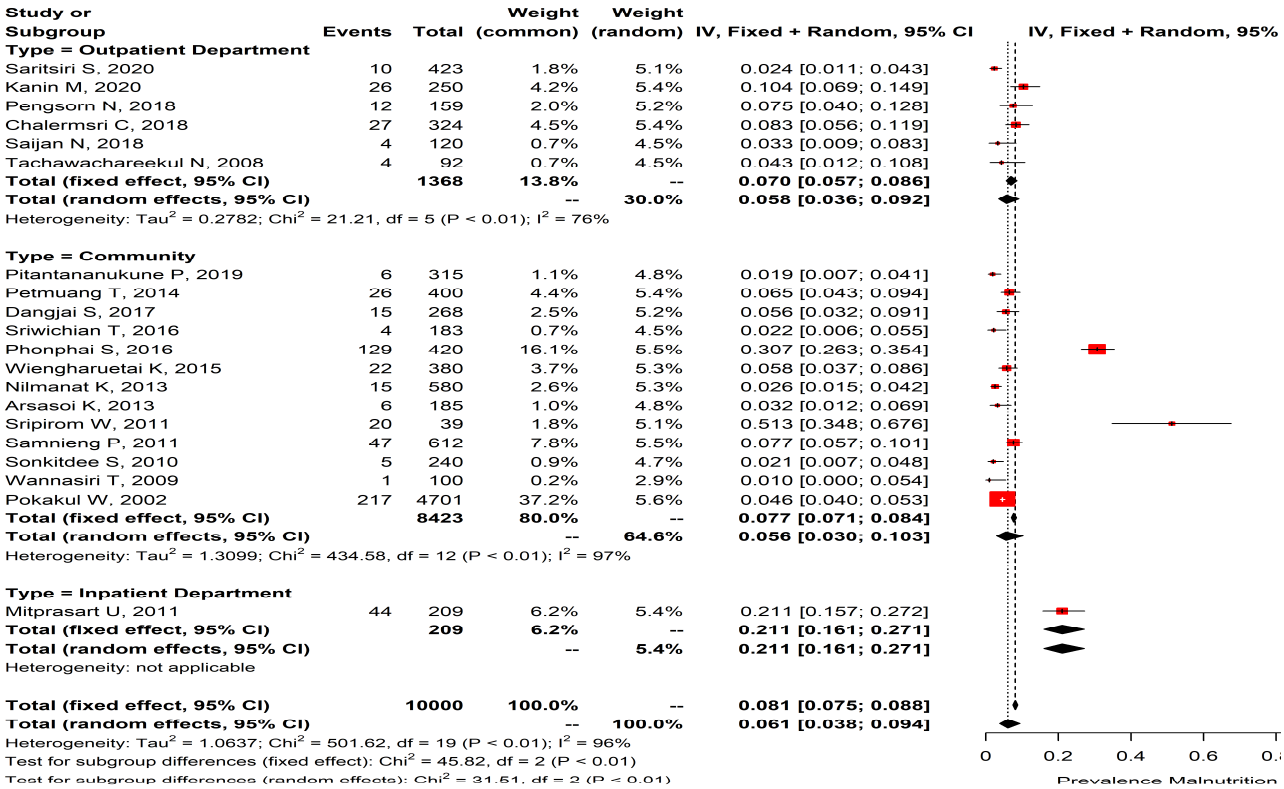

Figure 2. Forest plot of studies of malnutrition in older Thai people by MNA.

Associated factors of malnutrition

Malnutrition is more prevalent in rural[27] than urban communities. Malnutrition is associated with female gender,[23,29,88] advanced age,[23,27,29,33,40,41] low education,[29,88] single marital status,33 and living alone.[40] Comorbidities[40, 88] such as dementia,[29] depression,[29,41,46,78] cerebrovascular disease,[29] and more severe comorbidities (defined by a higher score of Charlson Comorbidities Index).[29] Eating-related problems related to malnutrition include appetite disorder,[33] number of teeth,[23,67,76] functional dentition,[36] mouth dryness,[88] and avoidance of eating vegetables and fruits.[88] In addition, geriatric conditions including functional decline,[29,40,78] frailty,[89] and polypharmacy[29] are associated with malnutrition.

Weight loss, poor appetite, swallowing and chewing difficulties

Though weight loss and poor appetite were included in the MNA, few studies reported each item separately. Most of the studies using MNA reported the total score of MNA and MNA-SF. Report of weight loss item was presented in only nine studies in which some studies defined weight loss as kilogram with different cutpoints and some defined as the percent of weight loss.[23,34,56,73-75,87,89,90] Using the loss of at least 3 kilograms as a cutpoint, the proportion of weight loss was 5-7.1% in the community-dwelling older people.[34,73,74,90] Using at least a 1-kilogram cutpoint, the proportion of weight loss ranged from 10.0-62.2% in the community-dwelling older people.[34,73,74,90] Using at least 5% of weight loss in the previous year, the reported prevalence of weight loss was 5.8-18.3% in the community-dwelling older people.[87,89] The prevalence of weight loss was reported in 83.4-85.2% in those with cancer and current hospitalization.[56,75]

Poor appetite and poor oral intake were reported in 7 studies as isolated items ranging from 1.92-36.2% in community-dwelling older people.[23,25,33,38,48,57,90] The swallowing difficulty was reported in 3.8-10% in the community, 15.7-43.1% in an in-patient, and 23.6% in a nursing home.[38,41,48,50,57] Difficulty in chewing was reported in 17.3-56.7% in a community setting, 39% in an OPD setting, 57.4-84.3% in an IPD setting, and 67.3% in a nursing home setting.[38,41,48-50,57,60,80,88]

Food choices of older people in Thailand

Several factors in older people's lives can affect food preferences and choices. The individual factors, nutritional knowledge, ethnicity, beliefs, and ecosystems factors; economic system, society, food safety, food sources can all contribute to individual food choice and habits in the older person.[96]

In this study, we found that both individual and ecosystem aspects are associated with under-nutrition in older people. Nutrition knowledge is one of the important factors that have been found associated with nutrition status in older people in Thailand.[25,47,66] Avoidance of certain food such as chicken, bamboo shoots, ferment foods, green hatching during sickness, and meat, catfish, or eels is due to personal belief.[48,71] Culture and ethnic background also influence the food choices; for example, Mon people prefer to eat a high-fiber diet and some tropical vegetables like Okra.[73] Even though older people in Thailand have relatively low incomes, most of them can access enough food.[25,28,37,38,48,60,71,82] Most older people in Thailand live and share meals with family, so the problem

of skipping meals that are related to social isolation is less common.[96] In terms of food sources, older people and families usually buy raw material from a local market or their farm,[37,51] and prepare foods at home rather than buying ready-to-eat, canned, or frozen food.[51,73] Furthermore, the cleanliness of food is a big concern of older people[28] and possibly correlates with the BMI of older people.[85]

The component of each meal (Table 2) and the quantity of food intake are also important factors that contribute to the under-nutrition problem.

Publication bias

Publication bias can affect the results of the meta-analysis and so a funnel plot was applied. There was publication bias among studies in the BMI tool (p=0.001) (Supplementary figure 10). However, studies using the MNA tool showed no publication bias (p=0.52) (Supplementary figure 11).

DISCUSSION

This meta-analysis included 71 studies and the pooled prevalence of malnutrition among older people in Thailand was 10.4% by BMI, 6.1% by MNA, and 5.7% by MNA-SF. Prevalence of at-risk of malnutrition was 42.6% by MNA and 37.8% by MNA-SF. The mean age of participants in each study ranged from 65.5 to 78.3 years. Poor appetite and chewing difficulty were common. Physiological, psychological, and socio-economic factors were associated with malnutrition.

BMI is the most commonly used tool in all settings, probably due to its simplicity and convenience. Other anthropometric measurements such as skinfold thickness, which reflects body fat, and muscle circumference of the mid-arm or calf, which reflects muscle mass, is not always reliable in Asian populations where reference values have not been established. Therefore, these methods are not suitable for assessing malnutrition in Thai people. In addition to BMI, MNA-SF and MNA are also commonly used for screening and assessment for malnutrition in older Thai people. Other validated tools include MUST, MST, NRS-2002, and SGA, none/few of which were used in studies in older Thai people and preventing meta-analysis. Some studies used biochemical markers to indicate malnutrition, of which serum albumin was the most commonly used. However, serum albumin is not appropriate in acute illness as it may be falsely elevated due to dehydration. Moreover, serum albumin may decrease in other causes such as inflammation, infections, trauma, heart failure, edema, liver dysfunction, and nephrotic syndrome. Lymphocyte, hemoglobin, or hematocrit are not specific to malnutrition and are also affected by other conditions.

The pooled prevalence of malnutrition assessed by MNA may be lower than with other tools as it contains the group of at-risk for malnutrition separately from malnutrition. Moreover, the MNA tool evaluates not only anthropometric measurements including BMI, but also overall physical health, neuropsychological problems, and self-evaluation of nutrition and health status. It can be difficult to get information from older people, especially those with cognitive impairment. In our study, the pooled prevalence of malnutrition by BMI was 10.4%, higher than the prevalence by the MNA tool (6.1%) and MNA-SF (5.7%). However, the prevalence of being at-risk of malnutrition by MNA and MNA-SF were 42.6% and 37.8%, respectively. The MNA was developed in western countries and the cut-off levels of some items, such as BMI below 19 kg/m^2, mid-arm circumference below 21 cm, and calf circumference below 31 cm, might be inappropriate in Asian populations. Our results suggest that the MNA may require further study to identify a more appropriate cut-off value to evaluate older Thai people for malnutrition.

The lowest prevalence of malnutrition was among community-dwelling older people which was 9.8% using the BMI and 5.6% using the MNA. The highest prevalence was among hospitalized older people, 16.3% and 21.1% by BMI and MNA, respectively. Older people in hospitals are more vulnerable to nutritional disorders, and acute illness leads to anorexia in older people. On the other hand, nutritional disorders might increase the risk of hospitalization due to infection, frequent exacerbation of chronic lung disease, or poor muscle mass leading to falls and fracture. A nutritional assessment should be performed during hospital admission, at least once weekly during a short hospital stay, every 15 days for rehabilitation care, and once monthly during long-term care.[97] Nutritional intervention as part of a multidisciplinary care team should be focused on hospitalized older people.

The higher malnutrition prevalence in rural[28] than urban communities aligns with previous research.[98] This may be because rural areas may have poorer dietary quality and micronutrient deficiency, leading to poor nutritional status. The current guidance by the Integrated care for older people (ICOPE) guidance is launched for primary care health workers to provide initial screening and care pathways in community-dwelling older people.[99] The first step is the screening by 2 questions regarding weight loss of 3 kilograms over the last 3 months and loss of appetite. The second step is the assessment of nutritional status by more comprehensive tools such as MNA, DETERMINE, or SNAQ. This recommendation is similar to the current Thai guidance for a community screening in the initial step by the older people themselves, family caregivers, or village health volunteers and followed by the MNA-SF/MNA in the second step by the healthcare professional.[100] This study may provide an information about malnutrition in older Thai people, which can be a reference data for the future study in aging population.

The varied reported prevalence among studies is likely from 3 reasons. First, the population characteristics in the studies are varied such as mean age (young old vs very old), community/ outpatient/ in-patient setting, and comorbid illness. Even in the same patient setting such as hospitalized patients, there were still differences in population studied in that patients were recruited from medical ward, new cancer patients scheduled for new chemotherapy session, and patients receiving urgent abdominal surgery. Second, the subjects included in the research usually had no communication or cognitive problems, did not require mechanical respiratory support or were not critically ill, and were able to be weighed. This inclusion and exclusion criteria could result in selection bias of relatively better health of subjects compared to those excluded.

Table 2. Food consumption behavior in older people in Thailand

Study	Population	Number of subjects	The most frequent consumption food products reported						Family and social
			Carbohydrate	Protein	Fat	Vegetable	Fruit	Frequency (meal/day)	
Boonchu K, 2002[25]	Community dwelling elders	65	Sticky rice	Fish	Fat from animal products	Cabbage, green onion, ivy gourd	Mango	3 times	*NA*
Inthamart P, 2013[37]	Community dwelling elders	205	Sticky rice	Milk and fish	Fat from animal products and vegetable oil	Local vegetable	General fruits	*NA*	Eat with family
Manojit T, 2006[48]	Elder nursing homes	55	Plain rice	Nonspecific meat and soy milk	Fat from animal products	Bog choy, water spinach, cabbage	Banana, orange papaya	3 times	Eat with company
Nasok W, 2019[51]	Community dwelling elders	96	Sticky rice	Nonspecific meat	Fat from animal and plant products	Green vegetable	*NA*	*NA*	*NA*
Pruksa S, 2018[64]	Community dwelling elders	281	Sticky rice	Fish	Vegetable oil	General vegetables	Orange, papaya, watermelon, rose apple, banana, pineapple	3 times	Eat with family
Suwittawat C, 2011[79]	Hospital	87	Sticky rice and plain rice	Fish	*NA*	General vegetables	General fruits	3 times	*NA*

NA: not available.

Therefore, there might be the underestimation of the true prevalence. Third, the criteria and screening tools used were different. The two most commonly used tools were BMI and MNA. This, in fact, should lead to a comparable prevalence. However, as older people tend to have decreased height either from osteoporosis or malalignment of spinal curvature resulting in falsely high BMI. Many older adults cannot stand or be weighed which limited the assessment of BMI in some places. Moreover, body weight contains both body fat and fat free body mass. People with normal or high BMI might have associated muscle loss and decline in muscle function called "sarcopenic obesity" which also have clinically important negative health outcomes. The MNA-SF also contains the BMI item. Though there is the option of assessing calf circumference (CC) in case of the difficulty to measure BMI, there was a report that BMI-incorporated MNA-SF showed higher accuracy as compared to CC-incorporated MNA-SF.[101] Moreover, in older people where there are problems with communication, consciousness or cognitive function, some of the items might not be able to score as they need recollection of information.

Older people in community-dwelling and OPD settings who had malnutrition had a higher proportion of sarcopenia as demonstrated by the Bioelectrical Analysis of body composition[29,43,86,102] and a higher proportion of pre-frailty, frailty, and cognitive frailty.[87,89,103] Both sarcopenia and frailty could lead to further negative health outcomes. Several factors associated with food choices and dietary practice include physical health, mental health, society, environment, and economic systems. Other issues leading to varying food choices are food preference (such as ethnic food preference, ready-to-eat foods), trust and concerns in the food market, and food safety.[96]

In other studies, especially in western countries, undernutrition is associated with decreased food intake from social isolation or psychological status. In contrast, Southeast Asian older people live with their families, providing food and taking care of them. In addition, the components of each meal and the number of daily meals seem to be expected (Table 2). Collectively, it seems that availability and quality of food may not be the main factors contributing to malnutrition status in these populations. Instead, the quantity of food intake itself could play a key factor in malnutrition. Even though the Ministry of Public Health provides information about nutrition and how to eat properly, the instruction may not be practical in real life. Moreover, older people usually have underlying diseases that limit specific food intake. It makes sense that loss of appetite is associated with malnutrition status and possibly be a warning sign of under-nutrition; however, the lack of patient's appetite data in many studies and standard measurements to evaluate appetite makes this relationship unclear.

In terms of availability, access, utilization, and stability, food security was surveyed in older people and found to be fair to good.[24,28,85] However, almost half of older people still had a poor to a fair level of food literacy, attitude toward Thai food-based dietary guidelines, and dietary habits following the guideline.[39,45,47,66,83] In addition, the primary resource the older people reported to receive the knowledge about food were from healthcare professionals, whereas public media was a less common resource.[25] This highlights the universal approach to public education. Several malnutrition-related factors could be modified. Poor appetite was common in older people, and some causes of poor appetite such as medication, depression, oral health, medical illness could be improved. The primary cause of the chewing difficulty is poor oral health, and dentation should be routinely screened and corrected. Food literacy, attitude toward national food guidelines, and dietary habits should be focused. Action toward other resources of appropriate dietary practice on top of healthcare professionals should be expanded. We summarize the conceptual framework of determinants and consequences of malnutrition in Figure 3.

Strengths

This is the first national estimate of the pooled prevalence of malnutrition and at-risk of malnutrition among older people in Thailand. We included all studies that used validated tools for screening and assessment of malnutrition with both published and unpublished data, and without language restriction. The subgroup analysis revealed different prevalences based on population characteristics, study setting and region. We also performed a systematic review of associated factors of malnutrition in older Thai people.

Limitations

Due to high heterogeneity, the random effect model prevalence should be used with caution. Interpreting the pooled prevalence should take this heterogeneity into account. Publication bias was detected in the studies using BMI, but not with the MNA tool. However, because data from multiple settings were included, the findings of this study may be generalized to the older people in both community and hospitalized settings.

Conclusions and implications

The pooled prevalence of malnutrition among older people was 6-10%, depending on assessment methods and study settings. Healthcare professionals should use appropriate malnutrition screening and assessment tools in the appropriate context. Older people should be weighed and BMI should be checked and monitored during every visit in general practice. These estimates can be used by policymakers and public health workers for controlling malnutrition and intervention strategies. Nutritional screening should focus on people with associated factors of malnutrition. Hospitalized older people are at greater risk of malnutrition. Several risk factors for malnutrition are modifiable. Developing a standard score for evaluating appetite in older people should become another interesting topic to better evaluate and manage older people with malnutrition problems. A routine check of oral health, chewing, and swallowing problems would lead to early corrective intervention for malnutrition. If malnutrition is detected early and treated promptly, its effects can be arrested and reversed, reducing illness and mortality.[104] We propose that the policy focus on giving a practical knowledge of nutrition that relates to the context of local culture. Multiple formats of delivering knowledge and appropriate dietary habits should be targeted.

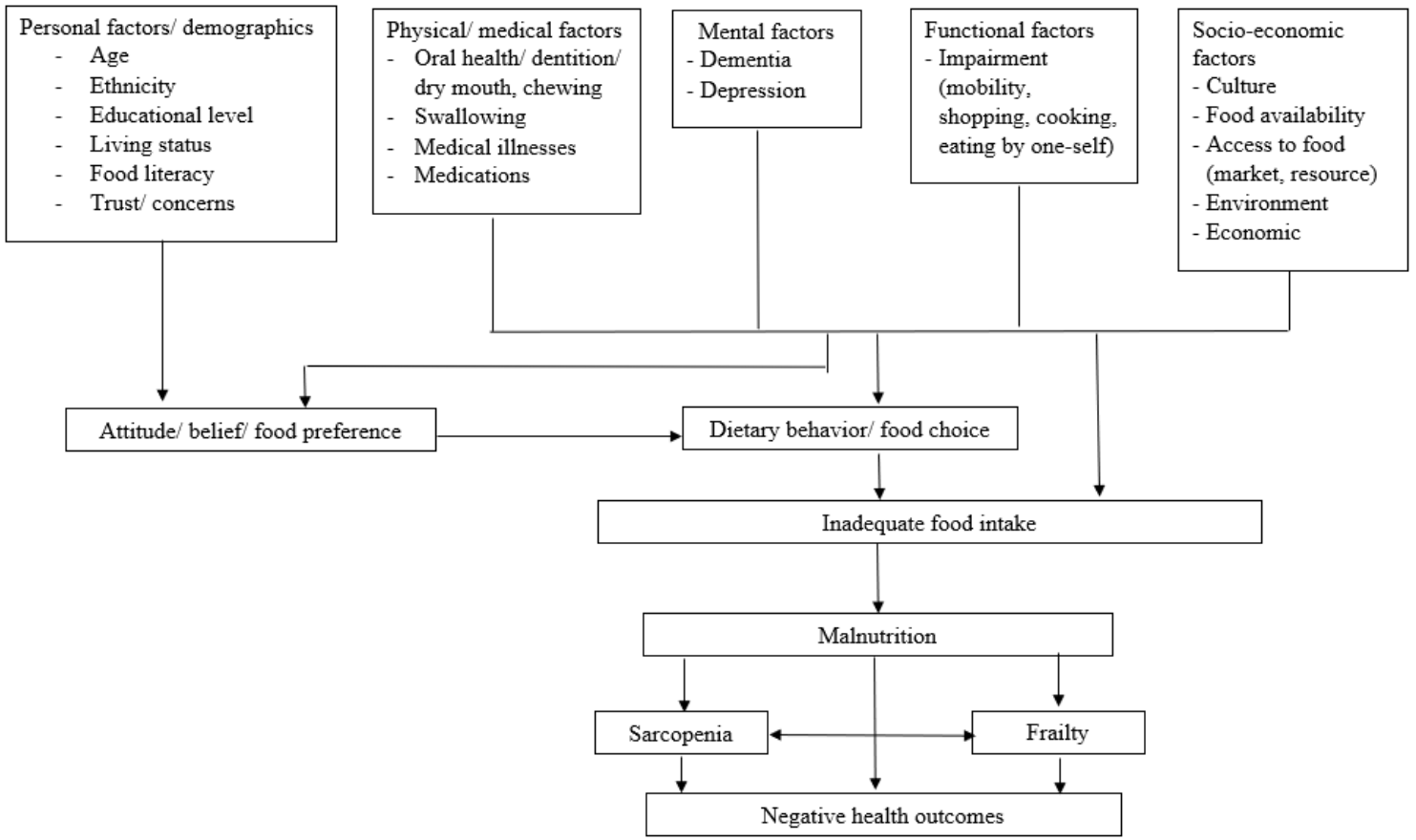

Figure 3. Conceptual framework for determinants and consequences of malnutrition in older people.

AUTHOR DISCLOSURES

The authors declare no conflict of interest.

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