



ISSN2434-2688

Asian Journal of Dietetics

Vol.6 No.3 & 4. 2024



**Official Journal of the Asian Federation of Dietetics Association (AFDA)
By Dietitians, For Dietitians
The charge for publication is free until the end of 2024.**



ISSN2434-2688 Asian Journal of Dietetics

Vol.6 No.3 & 4, 2024

Contents

Page	Title and authors
Special Report 69-88	Celebrating the 50th Anniversary of Thai Dietetic Association, 1974-2024 Sunard Taechangam, Chanida Pachotikarn
Special Report 89-92	Asian Young Dietitian Network Representative Attended the Session “Culture and Gastronomy: Spotlight on Washoku” at the 2024 World Food Forum Nguyen Mai Phuong
Review 93-98	Role of Nutrition and Dietetics in the Prevention of the Risk of Non-communicable Diseases in Thailand Yupa Chanwikrai, Sunard Taechangam, Chanida Pachotikarn, and Maitree Suttajit
Original Research 99-108	Some of Gastrointestinal Functions Among Elderly at Aged Care Center in Hanoi, Vietnam: A Cross-Sectional Study Linh Thuy Nguyen, Ha Ngoc Vu, Tuyet Chinh Thi Pham, Nga Thanh Ta, Hoang Thi Hai Yen
Original Research 109-120	Nutrition teacher’s class in elementary school and dietary pattern in adolescence Tohru Kobayashi, and Eisaku Okada
Original Research 121-126	The Role of Glutamine-Arginine-HMB Supplementation in Postoperative Wound Management in Gynecologic Cancer: Case Report Ho Chiou Yi, Nur Syahida Mohamad Sharif, Loh Siew Jing, Nursyafiqah Ahmad Rosfian, Muhammad Amirulhafidz Mat Arifin, Nur Afifah Nabila Mohd Rusmi, Sabena Malini A/P Vijayakumar, Norshariza Jamhuri, Mohd Norazam Mohd Abas, Jamil Omar
Original Research 127-136	Sensitivity of Malnutrition Screening Tool to Provide Individualized Nutrition Care for Surgical Patients by Dietitians F.A.Z. Firouse, A.M.N.T. Adikari, Leigh O’Brein, Catherine L. Wall
Original Research 137-140	Habitual Green Tea Consumption May Lower Systolic Blood Pressure Shin Yamaoka
Original Research 141-149	Association of Habitual Coffee Consumption with Probable Sarcopenia Assessed Using SARC-F in Community-Dwelling Japanese Older Adults: A Cross-Sectional Study Akinori Yaegashi, Otoha Kohata, Tohru Kobayashi, Nobuya Kimura, Mikako Sakaya, Rumi Ohta, Haruka Yokoyama

Specail Report

Celebrating the 50th Anniversary of Thai Dietetic Association, 1974-2024

Sunard Taechangam^{1*}, Chanida Pachotikarn²

¹*Advisory Committee of Thai Dietetic Association and Former President of AFDA*

²*Advisory Committee and Former President of Thai Dietetic Association*

On the occasion of the 50th Anniversary of Thai Dietetic Association (TDA), TDA would like to express our sincere thanks to the key contributors of TDA, TDA honorary advisory committee members, advisory committee members, dietitian members, TDA alliances and also the Asian Federation of Dietetic Associations (AFDA) with 12 national dietetic association members for our great collaboration and support that have made TDA widely recognized as the organization for dietetics professionals in Thailand. The purpose of this article

is to document the history of TDA, the development of dietetic profession in Thailand and what activities TDA organized to celebrate the TDA's 50th Anniversary.

Furthermore, on this special occasion, the Committee members of TDA would like to express its sincere gratitude to Her Royal Highness Princess Maha Chakri Sirindhorn for her great intention and commitment to achieving food and nutrition equity and a good quality of life for all.



Photo 1: Her Royal Highness Princess Maha Chakri Sirindhorn

Her Royal Highness's successful approach to food and nutrition improvement, especially among

schoolchildren, mothers, infants, and young children in remote and deprived communities, can inspire

* To whom correspondence should be addressed:
s.taechangam@gmail.com

those in the field and be more widely useful. Here is one example of Her Royal Highness Princess Maha Chakri Sirindhorn's work on food and nutrition development.

Empowering our Future through Agriculture for School Lunch Project: An Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn

*by Colonel Ass. Prof. Dr. Nantaporn Viravathana,
Advisor to the Office of Her Royal Highness Princess
Maha Chakri Sirindhorn's Projects*

The Agriculture for School Lunch Project was launched in Thailand in 1980 by Her Royal Highness Princess Maha Chakri Sirindhorn, who followed in the footsteps of His Majesty King Bhumibol Adulyadej and Her Majesty Queen Sirikit in improving the living conditions of Thai people. Most of them lived in remote and deprived communities, as well as those marginalised due to cultural or religious differences.

Her Royal Highness began the project by giving priority to children, as they are the most vulnerable and the hope for Thailand's future. To combat malnutrition among children, Her Royal Highness introduced a small-scale integrated farm to schools in remote areas instead of providing children with ready-to-eat meals. Children are assigned to work on the school farm. Produce from the school farm was used

The Story of TDA 50 Years Leading Up to Thai Dietetic Association Today

The Birth and Founding of Thai Dietetic Association

TDA was first established as the Thai Dietetic Club with the initiation of Assistant Professor Rasami Kantasewi who gathered personnel working in the field of nutrition and diet therapy and established the Thai Dietetic Club on February 2, 1974. Asst. Prof. Rasami was elected as the first president of Thai Dietetic Club and had supported the activities of the club all along. On March 18, 2005, the Thai Dietetic Club changed its status to the Thai Dietetic Association and became the Thai Dietetic Association of Thailand (TDA) on June 23, 2008. It is a non-profit professional organization. Assistant Professor Dr. Sunard Taechangam was elected as the first president of TDA. The objectives of TDA are to: promote the development of the dietetic profession, the quality dietetic practices and education of Thailand while also

as ingredients for children to prepare their own lunches.

According to Her Royal Highness's initiative, the Agriculture for School Lunch Project not only provides children with good meals but also equips them with knowledge, skills, and a positive attitude towards agriculture and nutrition, as well as vocational skills and environmental awareness while they are working on school agriculture. This process is known as learning by doing. Participation is also a key to sustainability. The project gave children, teachers, parents, and other community members the opportunity to work together, thus enhancing the development of the community. Over time, the aim of the Agriculture for School Lunch Project has shifted from a focus on agriculture for better nutrition to holistic development—to enhance the potential of children and youth in a balanced manner so that they grow up to be productive members of their communities and the nation. It is now known as a sustainable development model for achieving a better quality of life.

The project is currently being implemented in 901 schools, covering 1,514 villages in 52 provinces with 142,348 learners. Moreover, due to their effectiveness, Her Royal Highness's initiatives have expanded beyond the borders of Thailand to improve the quality of life, covering 79,133 learners in 107 schools in 10 countries in Asia.

enhancing the skills and potential of Thai dietitians, establish and promote a network of regional collaboration and linkages for nutrition and dietetic activities in Thailand, promote a network of scientific information exchange in nutrition and dietetics through organize meetings, workshops, conferences. and link with international organization of nutrition and dietetics.

The seven key contributors (Photo 2) supported the establishment and participation of TDA including Professor Emeritus Dr. Aree Valayasevi, Professor Emeritus Dr. Wichai Tanpaichitr, Professor Emeritus Dr. Kraisit Tantisirin, Assistant Professor Rasami Kantasewi, Mrs. Rujira Sammasut, Assistant Professor Dr. Sunard Taechangam, and Assistant Professor Dr. Chanida Pachotikarn. In addition, there were several important contributors that supported TDA including Professor Emeritus Dr. Khun Sakorn Thanamit, Associate Professor Chaowalit Rattanakul, Professor Emeritus Dr. Thep Himathongkam, and Professor Emeritus Dr. Surat Komindr (Photo 3).



Prof. Emer. Dr. Aree
Valayasevi



Prof. Emer. Dr. Vichai
Tanpaichitr



Prof. Emer. Dr. Karisid
Tantisirin



Ass. Prof. Rasami
Kantasewi



Mrs. Rujira
Sammasut



Ass. Prof. Dr. Sunard
Taechangam



Ass. Prof. Dr. Chanida
Pachotikarn

Photo 2: The Seven Key Contributors Supported the Establishment and Participation of TDA



Assoc. Prof. Chaowalit
Rattanakul



Prof. Emer. Dr. Khun
Sakorn Thanamit



Prof. Emer. Dr. Thep
Himathongkam



Prof. Emer. Dr. Surat
Komindr

Photo 3: The Four Important Contributors Supported TDA

TDA has built the relationship with dietetic and nutrition networks including the dietetic professional country members of Asian Federation of Dietetic Associations (AFDA) and International Confederation of Dietetic Associations (ICDA). TDA is one of the dietetic professional associations that co-founded the AFDA in 1991. AFDA consists of 12 country members of professional dietetic associations and AFDA celebrated its 30th anniversary in 2021. TDA also holds an experience in organizing international event, the 5th Asian Congress of Dietetics in 2010 (ACD 2010). It is with great pride that TDA hosted the 5th ACD. TDA was honored to have Minister of Public Health Jurin Laksanawisit, presided over the opening ceremony. With the successful hosting of the ACD, we received a good feedback from our AFDA members for organizing and hosting such a wonderful 5th ACD in Bangkok. The group members from Taiwan attended the congress reflect that this meeting was informative, intuitive, they enjoyed the warm hospitality, the delicious Thai cuisine, and they brought home lots of wonderful memories. Dr. Chwang Lei-Chii, Honorary President of AFDA mentioned that TDA set a benchmarking model for AFDA country members to follow. In addition, TDA became the 46th member of ICDA in 2022 and also participated in the ICDA activities: attending International Congress of Dietetics (ICD),



Photo 4: AFDA and the 12 AFDA Country Members



Photo 5: The Asian Dietitians' Activities

Registration/Licensing of Dietitians in Thailand

In 2016, TDA and academic institutions that offer the Nutrition and Dietetics programs submitted a proposal to the Department of Health Service Support, Ministry of Public Health, to consider the field of Dietetics as a field of Medical Practice. Later, on June 20, 2020, His Majesty the King graciously issued a Royal Decree defining the field of Dietetics as a branch of Medical Practice in 2020, in accordance with the Medical Practice Act B.E. 2542 and its amendments, and announced in the Government Gazette, Volume 137, Part 46 A, Page 40, dated June 23, 2020 (Photo 6 -7). There are 2550 dietitians passed the first registration examination out of 2577 eligible

members applying for the registration and taking the examination. Currently, there are 3,728 registered dietitians obtained a dietitian license. The Bureau of Sanatorium and Arts of Healing, Department of Health Service Support, Ministry of Public Health has appointed/elected the Dietetic Professional Committee. The Dietetic Professional Committee has issued an order appointing 4 Subcommittees for Dietetic Professional Disciplines. The Dietetic Professional Subcommittees consist of 1) Registration and Knowledge Examination, 2) Academic and Professional Standard Development, 3) Professional Ethics and Laws, and 4) Dietetic Educational Institution Assessment.



Photo 6: Dietitians Received a Royal Order



Photo 7: The First Meeting of the Professional Committee to Enact a Royal Decree on 2020

TDA also plays a role in collaboration with the Dietetic Professional Committee, the Bureau of Sanatorium and Arts of Healing, Department of Health Service Support, Ministry of Public Health, in developing work standards so that registered dietitians, nutritionists and dietitians who are licensed as a practitioner of the Arts of Healing can use them as a guideline in their work and keep up with changes in public health.

The Nutrition and Dietetics Program in Thailand

In 1955, Kasetsart University was the first university in Thailand to offer a bachelor’s degree in Home Economics with some courses in food and nutrition but a few courses in dietetics. In 1966, the Faculty of Public Health, Mahidol University, offered a bachelor’s degree in Nutrition and Dietetics, with a

62

300-hour internship. Later in 2000, the Institute of Nutrition, Mahidol University, in collaboration with the University of Toronto and St. Michael’s Hospital, Canada, offered a full-scale dietetics program, with a master’s degree in Nutrition and Dietetics, focusing on developing students’ skills in clinical dietetics and research, with a 900-1,000-hour internship. In the year 2005, the Faculty of Allied Health Sciences, Chulalongkorn University, offered a full-scale bachelor’s degree in Nutrition and Dietetics. Currently, there are 11 universities in Thailand that offer bachelor’s degree programs in Nutrition and Dietetics, and 1 university that offers master’s degree program. The dietetic students who complete the accredited Nutrition and Dietetic program with 900 hour internship are eligible to apply for the registration examination to get a dietitian license.



 **สมาคมนักกำหนดอาหาร**
THE THAI DIETETIC ASSOCIATION

1974



Thai Dietetic Association (TDA) was founded in 1974 as “Thai Dietetic Club” on 2nd February 1974 with 400 members

1976



The First Dietetic Meeting

1978



The First Journal of Dietetics

1991



TDA Co-Founded the Asian Federation of Dietetic Associations (AFDA) in 1991

2005



Thai Dietetic Club Changed to Thai Dietetic Association on 18th March 2005

2008



Thai Dietetic Association Changed to Thai Dietetic Association of Thailand (TDA) on 23rd June 2008

2009

TDA Organized the First Examination for Certified Dietitian of Thailand (CDT) on 31st October 2009. January 2024, there are 3,030 TDA Members Passing CDT Examination

2010



TDA Organized the 5th Asian Congress of Dietetics (ACD 2010)

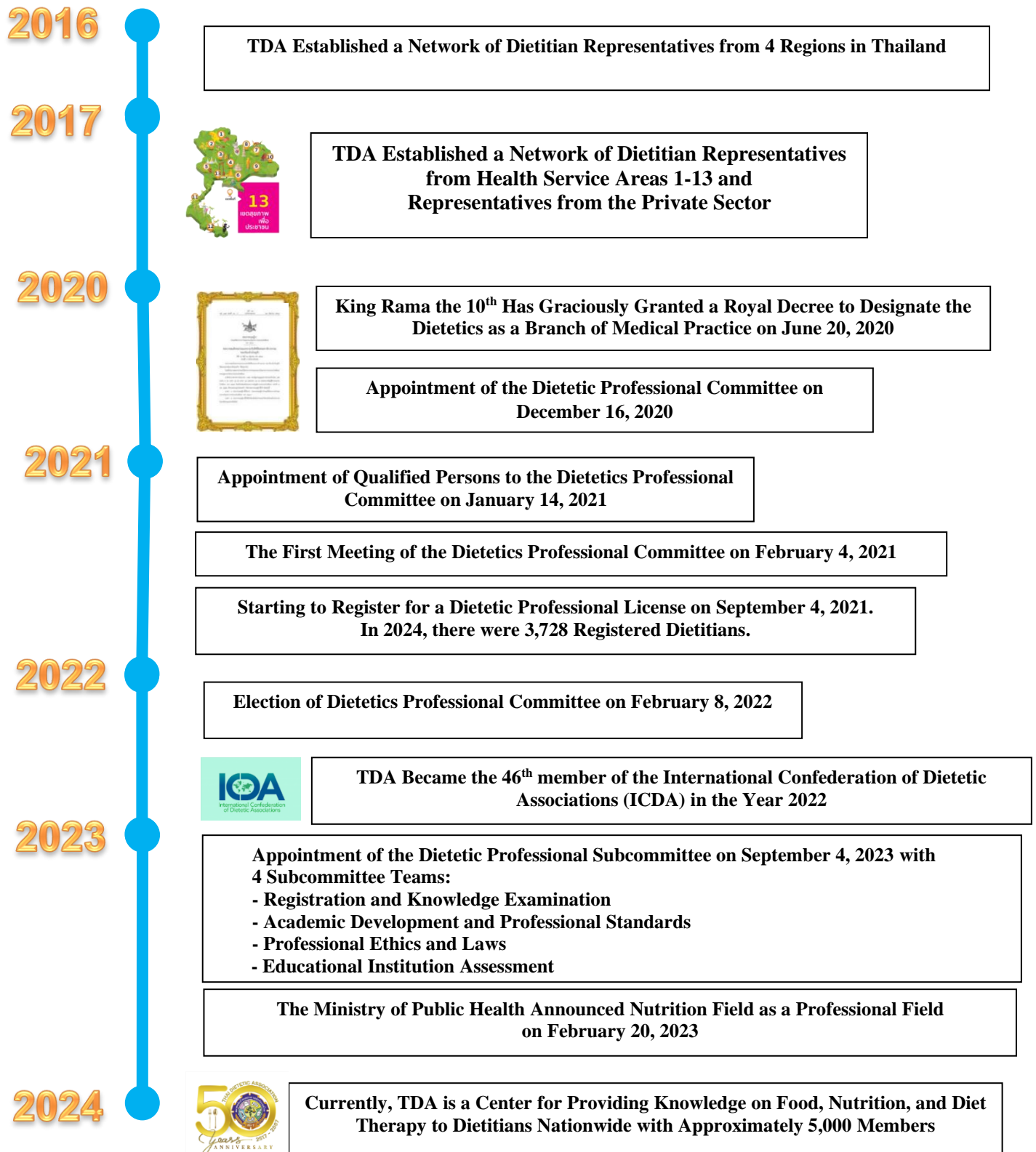


Photo 8: Timeline of Thai Dietetic Association, 1974-2024

The Born of Dietetic Profession in Thailand

Assistant Professor Rasami Kantasewi

The pioneer of dietetic profession and also the first dietitian in Thailand, is Assistant Professor Rasami Kantasewi, a graduate of the Faculty of Arts Chulalongkorn University in 1950. She received a scholarship to study dietetics at Park Ville College, USA. and did a dietetic internship at Standford

Hospital for 1 year. After returning to Thailand, she worked as a dietitian at McCormick Hospital, Chiang Mai for 3 years. In 1957, she transferred to Kasetsart University, Bangkok to work as a lecturer in food, nutrition and diet therapy under the Department of Home Economics for 10 years.



**Photo 9: Assistant Professor Rasami Kantasewi
The Pioneer of Dietetic Profession in Thailand and Her Lovely Family**

In 1965, the Faculty of Medicine, Ramathibodi Hospital was built. Professor Emeritus Dr. Aree Valayasevi, who was a co-founder of the Faculty, wanted someone with knowledge of food, nutrition and dietetics to work with in providing foodservices to hospitalized patients. He invited Asst. Prof. Rasami to work at Ramathibodi Hospital. Later in 1967, she transferred from Kasetsart University to work at Ramathibodi Hospital. Later, she received a Rockefeller scholarship to study hospital food administration at the University of Columbia, Kansas City, Missouri, U.S.A. In 1968, Asst. Prof. Rasami returned to Thailand and made plans to set up Division of Nutrition and Dietetics. She was well aware that there was no curriculum in Nutrition and Dietetics in Thailand at that time, no any course related to diet therapy, administrative and foodservice management for hospitalized patients, which was one reason why those working as dietitians at that time were not aware of their true duties as a dietitian.

On May 3, 1969, Ramathibodi Hospital, was opened for operation. In the early stages of the hospital's opening, Asst. Prof. Rasami devoted herself very hard to her work. Asst. Prof. Rasami initiated and gathered personnel working in the field of nutrition and diet therapy and established the Thai Dietetic Club in February 2, 1974. She received good support

from Professor Emeritus Dr. Aree, who was the Dean of the Faculty of Medicine, Ramathibodi Hospital at that time. He also allowed the use a part of the Nutrition and Dietetics office as the Thai Dietetic club's office. Asst. Prof. Rasami was elected as the first president of Thai Dietetic Club and had supported the activities of the club all along. She was the one who inspired the Thai medical community to realize the importance and necessity of using nutrition care process as well as medical nutrition therapy in treating patients with nutrition problems and made the physicians recognized the roles of dietitians for providing nutrition and diet therapy as well as diet counseling to patients. In 1974, she received a scholarship from the Netherlands government to study and observe the teaching activities and curriculum of nutrition and dietetics program in Netherlands. Upon returning from the Netherlands, she devoted her time to developing the nutrition and dietetic work under her responsibility.

A 4-month short-term training program "Diet Therapy and Administrative-Foodservice Management" for dietitians and nutritionists working in the hospital, was initiated in 1988 by Asst. Prof. Rasami and her team, along with the distinguished lecturers of the Faculty of Medicine, Ramathibodi Hospital. They realized the importance of providing

training especially nutrition therapy, so that dietitians and nutritionists could apply their knowledge to maximize the benefits of patients. Asst. Prof. Rasmi kindly gave advice in preparing the curriculum. In 1989, the first batch of students of the Diet Therapy and Administrative-Foodservice Management Program was opened under the direction of Mrs. Rujira Sammasut, the head of the Division of Nutrition and Dietetics at that time. The training program has been in operation for 33 batches until now.

Asst. Prof. Rasami retired in 1984. She continuously joined as a special lecturer for the training program. She passed away on June 13, 1998. Asst. Prof. Rasami's good deeds that were evident are worthy of being considered as a role model of dietetic profession to be followed. Most importantly, she was the one who ignited the path for those working as dietitians and nutritionists in the hospital to realize the importance of their work and to have the opportunity to work in accordance with their position and responsibilities. This allowed dietitians to participate in patient care, and made doctors and medical personnel begin to realize the importance of the dietitian profession, and led to advancement in this dietetic career.

Associate Professor Chaowalit Rattanakul

The another pioneer of dietetic profession in Thailand is Associate Professor Chaowalit Rattanakul. She is one of the founding member and Advisory Board of TDA. In addition, she is also a pioneering member of the Thai Nutrition Society. Assoc. Prof. Chaowalit has been in the dietetics field since 1953. She graduated with a Bachelor of Science degree in Pharmacy from Mahidol University, and received a scholarship from the British Council, Thailand to continue her studies in nutrition at the College of Domestic Science, Glasgow, Scotland. Her 6-months clinical nutrition internship covered both in-patient and out-patient at the University College Hospital (London University), Guy's Hospital, Middlesex Hospital, Children's Hospital, and London Hospital in the United Kingdom. In 1961, Assoc. Prof. Chaowalit received another scholarship from Columbia University, New York to further her studies in Public Health, where she had the opportunity to train in the community settings at the Department of Health, Westchester County, New York and at the American Heart Association.

She taught Chemistry at Trium Udom Suksa School before she continued her nutrition degree in the United Kingdom and the United States of America.

She, then, taught Home Economics at Srinakarinviroj University for 21 years until retirement at age 60, where she was Head of Department of Home Economics. Assoc. Prof. Chaowalit's passion in teaching in nutrition, she did not stop at retirement. She continued to work in this field as a volunteer clinical dietitian at Chulalongkorn University Renal Unit, Police Hospital Department of Medicine, Baan Paew Hospital CAPD clinic, and Sirintorn Medical Center Dialysis Unit, providing Medical Nutrition Therapy to patients and in-services on food safety for hospitals' employee in food service department. She wanted to empower hypertensive patients to do self-care for prevention of disease progress. With this practice in mind, she has donated blood pressure machines to the renal units and out-patient units in several hospitals, which are available for loan for interested patients who cannot afford to purchase one. Furthermore, Assoc. Prof. Chaowalit is also a special lecturer on Preventive Measures for Diabetes and Diabetes Against Renal Progression for Vientien University Medical School, Lao. She is a tour lecturer for "Fight Against Diabetes" program sponsored by "Equal"; an honorary member and a special lecturer for the Rotary Club of Phayathai Bangkok; and is a volunteer speaker for the Elderly Club of Samutprakarn and for Chui Chee Foundation. In addition to the volunteer work as a clinical dietitian and special lecturer, Assoc. Prof. Chaowalit has been involved in several research and experimental projects, including the use of FOS in therapeutic diets, the use of combizym in Blenderized Diets to improve formula concentrations.

Assoc. Prof. Chaowalit's accomplishments covered both aspects of education and nutrition practice:

- She translated "Nutrition in Action" and "Nutrition Education in Action" both by Dr. Ethel Austin Martin, which was sponsored by UNICEF, used as a teaching tool in Institutions throughout Thailand.
- She integrated 2 compulsory courses, "School Food Science" and "Human Nutrition" for all students of the Bachelor of Education curriculum with a minor in Nutrition, which combined food sanitation with diet in health and disease topics.
- She wrote papers on school foodservice with emphasis on its nutritional and educational contribution to children, and School Lunch Program based on recommendations from the International Bureau of Education of UNESCO.
- She was a strong voice in the Thai Home Economics Society to recommend the Ministry

of Education to initiate a free school lunch program based on the recommendations from the International Bureau of Education of UNESCO.

- She wrote a handbook for renal patients, made an educational CD of the Thai Renal Food Exchange, and numerous educational tools such as pamphlets and posters on dietary practices.
- She conducted courses on renal diet for renal nurses throughout Thailand.

Assoc. Prof. Chaowalit's motto in life was "students were her VIPs during her teaching days, and patients were her VIPs after her retirement"; in which she continued to work hard in the clinical field and was a role model to every student she has taught. Her ultimate goals for her patients were to prevent diabetes and hypertension's disease progress and complications, for her patients' to have improved quality of life, and for her community to be as green and as healthy as possible. As a teacher and clinical

dietitian, Assoc. Prof. Chaowalit's proudest moments were seeing her students' success in both academia and personal lives, and seeing improvement and stabilization in her patients' conditions. Assoc. Prof. Chaowalit received many recognitions and awards including: Outstanding teacher from Srinakarinviroj University, capable and dedicated nutritionist /dietitian from Police Hospital, valuable contributor to the foundation from the Kidney Foundation of Thailand under Royal Patronage, and conscientious teacher from renal unit of Chulalongkorn Hospital.

At the opening ceremony of the 5th ACD in 2010, Minister of Public Health Jurin Laksanawisit presented "a Lifetime Achievement Award" from TDA to Assoc. Prof. Chaowalit for her significant contributions to the advancement of the field of dietetics as well as her years of dedication and tireless service to all. This prestigious symbol of recognition by her peers was appropriate and well deserved.



Photo 10: At ACD 2010, Minister of Public Health Jurin Laksanawisit presented a plaque of honor to Assoc. Prof. Chawalit Rattanakul who has dedicated herself to the Thai dietetic profession

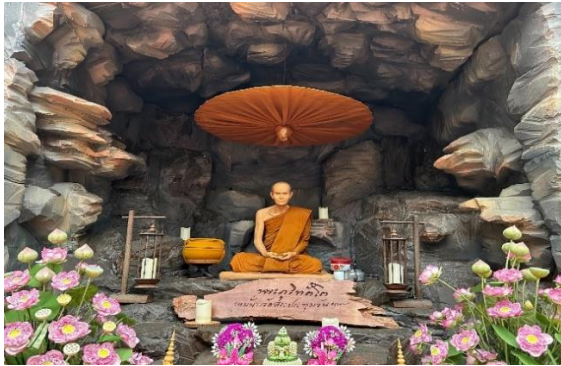


Photo 11: Luang Pu Man Phurittuto, The Headmaster of the Forest Temple Family

On the occasion of Thai Dietetic Association's 50th Anniversary of founding on February 2nd, 1974,

TDA organized a merit-making ceremony to present food and talipot fan to 9 monks for good fortune on February 17th 2024 at Wat Pathumwanaram Ratchaworawihan. The honorary advisory committee and advisory committee of TDA including Professor Emeritus Dr. Kraissid Tantisirin, Professor Emeritus Dr. Thep Himathongkam, Professor Emeritus Dr. Kriang Tangsanga, Mrs. Rujira Sammasut, Assistant Professor Dr. Sunard Taechangam and Mr. Niti Yimyam joined the event, along with the committee and the former committee members of TDA. Thank you to all those who attended the merit-making ceremony. May the benefits of this merit affect everyone who joined in making merit. Be an inspiration to all. Be happy with wealth, good fortune, prosperity, and good health.



Photo 12: TDA Presented Talipot Fan to 9 Monks



Photo 13: Professor Emeritus Dr. Kraissid Tantisirin Honored to Preside over the Merit-Making Ceremony



Photo 14: TDA Honorary Advisory Committee, Advisory Committee Members and the TDA Committee Participated in the Merit-Making Ceremony for the 50th Anniversary of TDA



Photo 15: The Symbol of the TDA 50th Anniversary

The Symbol of TDA 50th Anniversary

TDA has designed a specific symbol for TDA 50th anniversary celebration (Photo 15). The meaning of the TDA 50th Anniversary Symbol is as follows:

The Number 50 is 50 years, arranged in a connected line similar to the infinity symbol, conveying the existence, steadily advancing endlessly.

The Gold Color conveys progress, the wealth of professional value, and steadily advancing endlessly.

The Spoon and Fork are placed in a circle, conveying the plate-spoon and fork, equipment used for food consumption, linked to the TDA logo, showing the association's mission, leading to healthy food consumption and appropriate consumption for diseases.

The TDA Logo is placed in the number 50 years, conveying the 50th anniversary of the Thai Dietetic Association.

The Lines, interlocked into the number 50, represent cooperation in developing TDA towards progress, for healthy food consumption and appropriate consumption for diseases, throughout the 50th year and forever in a sustainable manner.

The Curved Lines, interlocked in a circle, mean providing academic services that meet the needs of Thai society and connecting to the international community.

The Thai Dietetic Association 50th Anniversary Celebration

With this special occasion, TDA arranged a 50th Gold Anniversary Celebration event on the evening of April 28th, 2024, and also organized the 44th TDA Annual Academic Conference 2024 on April 28th – 30th, 2024 at the Berkeley Hotel, Pratunam, Bangkok. TDA has prepared a 50th anniversary commemorative book and a 50th anniversary glass as the token of appreciation for our honorary guests who have supported TDA and also attended the TDA 50th Anniversary Celebration event. Furthermore, our distinguished guests including Professor Emeritus Dr. Kraisid Tantisirin, Professor Emeritus Dr. Thep Himathongkam, Professor Emeritus Dr. Kriang Tangsanga, Professor Dr. Surat Komindr, Professor Dr. Shigeru Yamamoto, Dr. Thares Krasanairawiwong, Dr. Akom Praditsuwan, and Dr. Chwang Leh-Chii, they kindly wrote the congratulatory remarks for TDA 50th Anniversary in the 50th Anniversary commemorative book. TDA committee members would like to take this opportunity to express our sincere gratitude for their concern and kindness

There were about 200 honored guests participated in the celebration event. TDA was delighted to have honored guests from alliances in Thailand as shown in Photo 16 including the private partners in Thailand that have supported TDA activities and provided research funds, and also TDA dietitian members from various hospitals in Thailand. Moreover, TDA was grateful to have 15 foreign guests joined the event including our distinguished guests from AFDA country members; Japan Dietetic Association (JDA), Chinese Dietetic Society (CDS, Taiwan), Malaysian Dietitians' Association (MDA) as well as the private stakeholders from Japan that have supported the TDA Dietetic Research Awards. We got good feedback from our guests that they enjoyed very much to join the celebrating of TDA 50th Gold Anniversary. The performance was wonderful with a good show. The food was delicious with the authentic Thai cuisine and nice decoration. Dr. Chwang Lei-Chii, Honorary President of AFDA and President of CDS, Taiwan, commented that TDA did such a wonderful job, and everyone in TDA and alliances would appreciate and remember this significant day.



Photo 16: The Alliances of TDA in Thailand



Photo 17: TDA 50th Anniversary Commemorative Book



Photo 18: TDA 50th Anniversary Glass



Photo 19: TDA 50th Anniversary Portable Stainless Steel Water Bottle

The Souvenirs for TDA 50th Anniversary and Attending TDA Conference 2024



Photo 20: Opening Ceremony of TDA 50th Gold Anniversary Celebration



Photo 21: TDA Committee Members and Honored Guests joined the TDA 50th Anniversary Celebration

TDA 50th Gold Anniversary Celebration Event



Photo 22: Special Puppet Show

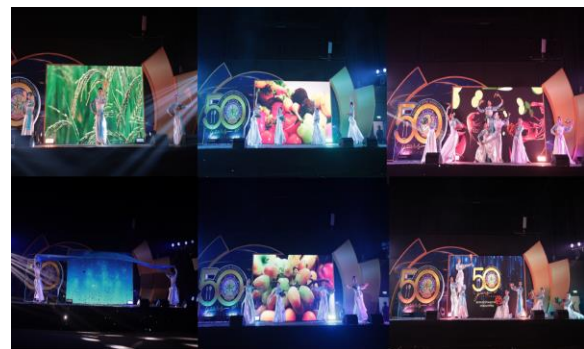


Photo 23: Contemporary Performance



Photo 24: Drum Sabatchai Performance



Photo 25: Four Regions Performance



**Photo 26: Ramwong Performance & Guests
Joining the Performance**



Photo 27: Live Music Performance

The Beautiful and Memorable Performances

As mentioned before, TDA organized the 44th TDA Annual Conference 2024 themed “Application of Diet Therapy into Lifestyle Medicine: What we should know”. The conference offered in hybrid meeting platform. There were about 1,600 dietitians and nutritionists attended the conference with 930 onsite participants and 670 online participants. TDA also prepared a 50th anniversary portable stainless steel water bottle as a souvenir to TDA members, dietitians and nutritionists, who joined the academic conference 2024.

To celebrate TDA 50th Anniversary, TDA was honored to have Dr. Opas Karnkawinpong, Permanent Secretary of the Ministry of Public Health, presided over the opening ceremony and also gave a special lecture “Lifestyle Medicine: The Importance of Nutrition and Dietetics”. Furthermore, there were 3 special symposia with the 4 invited speakers from abroad. The first symposium was AFDA symposium “What is the Next Path of Asian Dietetic Profession? - Opportunities for Asian Dietetic Challenges”

presented by Dr. Chwang Lee-Chii, Honorary President of AFDA and & Honorary President of CDS, Taiwan; Dr. Teiji Nakamura, President of AFDA and President of JDA; and Madame Mary Easaw, MDA member. The second symposium was “What Dietitians Need for the Future: Evidence-Based Dietetics” presented by Professor Dr. Shigeru Yamamoto from Graduate School of Jumonji University, Japan, and the last symposium was “Symposium of Asian Young Dietitian Network (AYDN)” presented about the establishment and activities of Asian Young Dietitians Network by AYDN members. TDA was delighted to have 19 AYDN members from 12 countries, Bangladesh, Bhutan, Cambodia, India, Indonesia, Japan, Malaysia, Philippines, Sri Lanka, Taiwan, Thailand and Vietnam, participated in the Conference. This is especially a stimulating experience for our young dietitians. TDA is looking forward to the new generation of competent young dietitians and wishing them a successful career



Photo 28: His Majesty King Bhumibol Adulyadej and Her Royal Highness Princess Maha Chakri Sirindhorn



Photo 29: The Exhibition of Timeline for TDA History

The Exhibition of The 44th TDA Annual Academic Conference 2024



Photo 30: Opening Ceremony of TDA Annual Conference 2024



Photo 31: Proceeding of TDA Conference 2024



Photo 32: AFDA symposium - Dr. Chanida Pachotikarn, Dr. Chwang Lee-Chii, Dr. Teiji Nakamura, Mrs. Mary Easaw



Photo 33: Symposium "What Dietitians Need for the Future Evidence-Based Dietetics" Professor Dr. Shigeru Yamamoto



Photo 34: Symposium of Asian Young Dietitian Network



Photo 35: The 19 AYDN Members from 12 Countries

In addition, Professor Emeritus Dr. Maitree Suttajit kindly wrote an article “Lifestyle Care and Dietetics in G6PD Deficiency” as a compliment for TDA 50th Anniversary. He reviewed information on the causes and mechanisms including methods to

prevent life risk in G6PD enzyme deficiency (Photo 36). TDA Committee would like to take this opportunity to express our sincere thanks and appreciation to Professor Emeritus Dr. Maitree Suttajit for the informative article and his kindness.

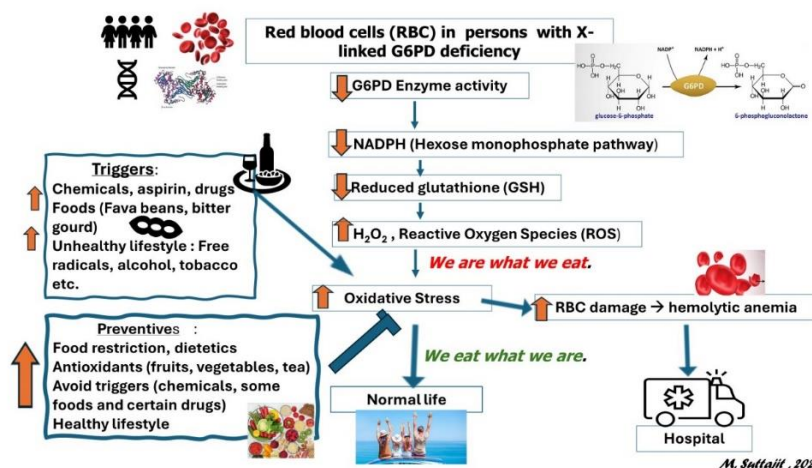


Photo 36: The Causes and Mechanisms including Methods to Prevent Life Risk in G6PD Enzyme Deficiency

Conclusion

In celebration of the TDA 50th Anniversary, give us a chance to reflect on our Thai Dietetic Associations’ history and events, our founders and pioneer leaders as well as the members of TDA who have made great contributions to nutrition and dietetics promotion in Thailand and also to look at the challenges and future directions to come. Our dietetic professions have come a long way with many challenges in the last five decade but yet a unique opportunities for innovation and collaboration among us to promote the value of the dietetic professions that

we can make a difference in health and well-being through food, nutrition and dietetics.

On this occasion, the TDA committee members would like to thank the devoted and committed pioneers and many colleagues that have been untiringly devoted themselves during the past 5 decades. There have been inspiring collaborative events of dietetics through active participation of all TDA members and to upgrade dietetic profession and network linkages for TDA. Especially the TDA members from Nutrition and Dietetic Departments all over the country in 13 health districts who actively

participate regional networking of dietetics among TDA members and have combined the power of unity of the teams and have worked together with good ethics in their professional practice, continuous development and professional advancement. Make the dietetic profession and TDA acceptable to medical professional and the general public and further make the Thai Dietetic Profession move forward to the international level.

Furthermore, we do hope that our Asian dietetic professional members of the National Dietetic Associations in Asia have to join our hands together to enhance health and well-being in Asian population through the innovative evidence-based dietetic practices. Lastly, TDA would like to thank AFDA that brings us to work together toward our mutual vision, moving forward together to accomplish our common goal and to further develop the AFDA through further cooperation of the dietetic associations of each country.

REFERENCES

1. Chwang LC: The Rise of Nutrition and Dietetics in Asia. 2019. Asian J Dietetics 1: 1-3. <http://jnl.calorie-smile.jp>
2. Chwang LC: History of Asian Federation of Dietetic Associations: Celebrating the 30th Anniversary, 1991-2021. Asian J Dietetics Vol 3, No 3, 2021. 67-77. <http://jnl.calorie-smile.jp>
3. Sunard Taechangam1, Chanida Pachotikarn: Thai Dietetic Association: Celebrating the AFDA 30th Anniversary. Asian J Dietetics Vol 3, No 3, 2021. 81-85. <http://jnl.calorie-smile.jp>
4. Teiji Nakamura, Development of Asian dietetics and the further solidarity of dietitians. Asian J Dietetics Vol 3, No 3, 2021. 87. <http://jnl.calorie-smile.jp>
5. Japan Dietetic Association: About JDA. Outline of the Japan Dietetic Association. <https://www.dietitian.or.jp/english>

Special Report:**Asian Young Dietitian Network Representative Attended the Session “Culture and Gastronomy: Spotlight on Washoku” at the 2024 World Food Forum**

Nguyen Mai Phuong^{1,2,*}

¹Asian Young Dietitian Network

²Quest-Computer Co., Ltd., Tokyo, Japan

About the World Food Forum

The World Food Forum (WFF), launched in 2021 as an independent network of partners hosted by the Food and Agriculture Organization of the United Nations (FAO), serves as the premier global intergenerational platform to actively shape agrifood systems for a better food future, accelerating the achievement of the Sustainable Development Goals. Through youth action, science and innovation, and investment, the WFF forges new paths of action and multi-sector partnerships for agrifood impact at the local, regional and global levels to achieve a more sustainable, resilient, inclusive and hunger-free food future for all (1).

In 2024, the WFF flagship event was held from 14 to 18 October at the headquarters of FAO in Rome, Italy, and online. Like previous years, it was structured around three main pillars: Global Youth Action, Science and Innovation, and Hand-in-Hand Investment (1). Under the banner of “Good food for all, for today and tomorrow” the WFF rallied participants to engage in learning, knowledge-sharing and partnership-building. It celebrated innovative solutions, fostered investment in agrifood systems transformation, mobilized support for cutting-edge research, and forged connections among leaders and youth who are shaping a more resilient food future (1).

).



Fig. 1 & Fig. 2: Photos of the 2024 WFF event at the FAO Headquarters Hall, Rome, Italy

Culture and Gastronomy: Spotlight on Washoku Session

Washoku was inscribed on UNESCO’s Representative List of the Intangible Cultural Heritage of Humanity on December 4, 2013. Washoku was recognized for its emphasis on respect for nature, the use of seasonal ingredients, and traditional culinary customs in Japanese cuisine.

In addition to ensuring a good and stable global food supply chain, FAO also recognizes that establishing healthy eating habits and balanced nutrition directly impacts human health.

Therefore, a session on Washoku was organized at the main stage on the first floor of the FAO headquarters in Rome, Italy, at 11:50 AM on October 17, as part of the 2024 WFF flagship event.

*To whom correspondence should be addressed:
youngdietitiannetwork@gmail.com

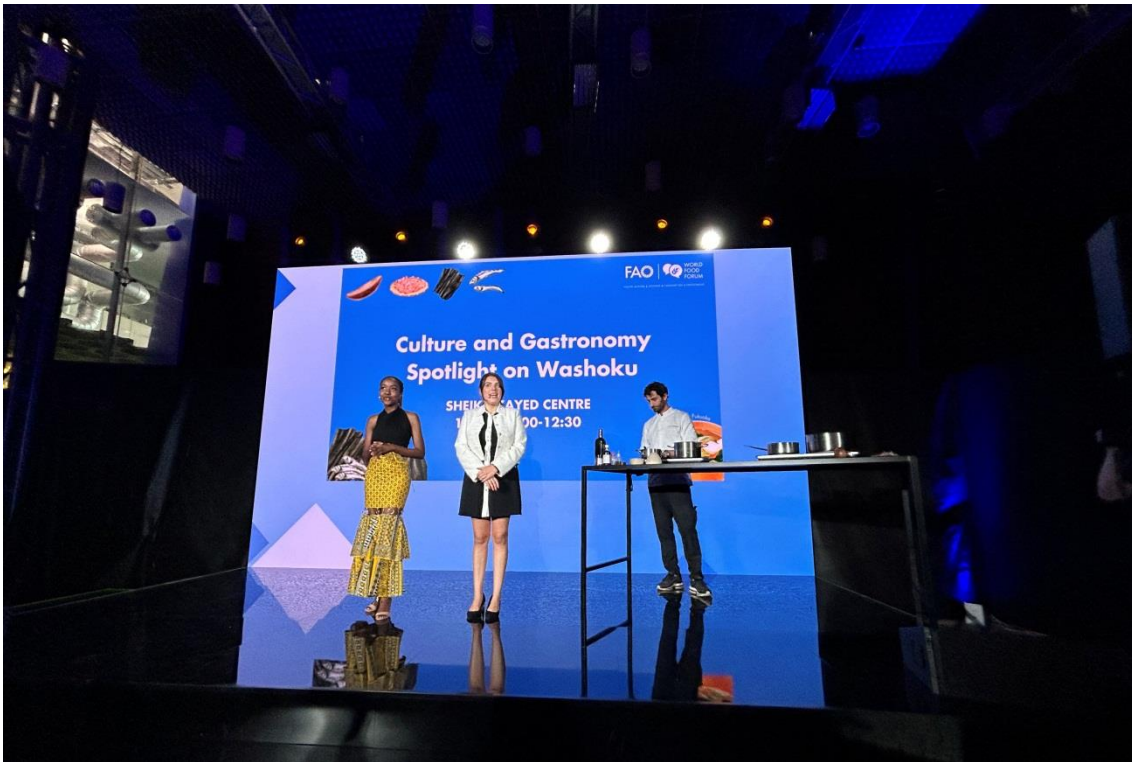


Fig. 3: Photo of Culture and Gastronomy: Spotlight on Washoku Session

The Asian Young Dietitian Network (AYDN) has proposed nominating a young dietitian to participate in the panel discussion of this event. AYDN was formally established on December 1, 2023, with the support of Ajinomoto and the Asian Nutrition and Food Culture Research Center at Jumonji University. The network was officially launched with the participation of twelve countries in Tokyo, Japan. Its objective is to enhance communication among dietitians across Asia to improve the region's nutritional status and elevate the reputation of dietitians (2). As a young dietitian who graduated from the first Bachelor of Nutrition program in Vietnam at Hanoi Medical University, I had the opportunity to pursue a Ph.D. in Japan, where I spent over five years researching Japanese

school meals. Consequently, I am honored to represent AYDN at this event. I shared my experiences and insights on traditional cooking methods and best practices of *Washoku*. Additionally, I provided a general comparison between *Washoku* and traditional Vietnamese cuisine in terms of technique, practice, and philosophy.

The panel discussion also featured three young representatives from Japan and the UK. They shared their perspectives on how to preserve and promote the traditional Japanese culinary culture, *Washoku*, in today's context, as well as how to engage and inspire younger generations to explore and practice *Washoku* in their daily lives.



Fig. 4: Photo of Panel Discussion

The final part of the session included a demonstration of dashi preparation by a Japanese chef and a European chef, followed by a tasting of the dashi by the participants.



Fig. 5: Photo of Dashi Cooking Demonstration

I believe this event was highly meaningful, as most of the attendees were young people from around the world, both offline and online. I hope that through this event, young people can truly recognize the significance of traditional Japanese cuisine, Washoku, in fostering a balanced and nutritious diet, thereby contributing to the improvement of health and longevity in Japan. (3)

Impressions of the 2024 World Food Forum

The 2024 WFF left a deep impression on me in many ways. It was inspiring to see a global platform dedicated exclusively to young people, enabling them to actively engage in discussions on food security, agricultural development, forest conservation, and the preservation of food culture.

One of the most remarkable aspects of the WFF was the strong emphasis on youth participation and leadership. The event showcased how young people's initiatives are not only encouraged but also supported by experienced professionals, senior experts, and key figures in related organizations. This mentorship and collaboration are crucial for ensuring that youth-led actions have a real impact.

Another key takeaway was the importance of multi-sectoral collaboration. For example, if the AYDN focuses on the nutrition and dietetic training program (4), it is essential to involve educational institutions, government ministries, and policymakers in discussions. Likewise, if we aim to influence policies or legal frameworks, engaging with relevant experts, health ministries, and government officials becomes indispensable. All discussions should be systematically documented and presented to authorities as evidence to drive meaningful change.

Additionally, I was particularly impressed by how WFF provides a space for young

professionals to connect, exchange ideas, and learn from one another. The event was short, but the friendships and networks built among young leaders from different countries were a significant achievement.

However, one aspect that stood out was the limited participation of Asian representatives at this year's event. Moving forward, I hope to contribute to enhancing information-sharing across Asia so that more representatives from different Asian countries can actively participate in future WFFs.

The 2024 WFF reaffirmed my belief that young people have a critical role in shaping the future of food and agriculture. I look forward to seeing more meaningful initiatives and hope to continue engaging in activities that benefit young dietitians across Asia, especially in Vietnam.

References

- 1) FAO and WFF. 2025. World Food Forum 2024 – Results report. Rome, FAO. <https://openknowledge.fao.org/server/api/core/bitstreams/1dd0eb08-ea57-4ca4-aaa0-7bc5cb256f18/content> . Accessed December 28, 2024.
- 2) Trang Thu Nguyen, Andrea Wakita. 2. The birth of the Asian Young Dietitian Network. *Asian Journal of Dietetics* 5 (4): 142. 2023.
- 3) Ana San Gabriel, Kumiko Ninomiya and Hisayuki Uneyama. The Role of the Japanese Traditional Diet in Healthy and Sustainable Dietary Patterns around the World. *Nutrients* 10(2):173. 2018.
- 4) F.A.Z.Firouse, Nur Ayu Ruhmayanti, Sumaya Islam, Yen Ngoc Ma. Special Report: Asian Young Dietitian Network. *Asian Journal of Dietetics* 6 (1-2): 40. 2024.

Review

Role of Nutrition and Dietetics in the Prevention of the Risk of Non-communicable Diseases in Thailand

Yupa Chanwikrai¹, Sunard Taechangam², Chanida Pachotikarn², and Maitree Suttajit^{3,*}

¹*Division of Nutrition, Faculty of Medical Sciences, University of Phayao, Phayao, Thailand*

²*Thai Dietetic Association, Bangkok, Thailand*

³*Thai International Vegetarian Association, Thailand*

ABSTRACT *Background and Purpose.* Non-communicable diseases (NCDs) are increasing globally and have become the leading cause of health-related economic problems and death in Thailand and Asian countries, mostly under the age of 70, as reported by the World Health Organization (WHO). The risk factors that rapidly raise the burden of NCDs are alcohol, unhealthy diets, physical inactivity, and air pollution. The most effective way to solve these problems may be through public education, especially in healthy nutrition and diet. *Purpose.* This review highlights how plant-based nutrition and dietetics play a significant and potential role in preventing and reducing NCDs in Thailand. *Methods.* We conducted a systematic search of the PubMed database by combining the terms "dietary intake, nutritional status, phytonutrients, dietetics, plant-based, NCDs, nutrition, prevention, WHO" with the term "NCDs." and a question: "How much nutrition and dietetics involve and affect NCD risk?" was studied and summarized. *Results.* Nutrition and dietetics strongly impact NCD risk in Thailand and other countries. The Thai government is urged to develop the 5-Year National Prevention and Control Plan to enhance awareness of prevention in communities. The national plan must focus on the change in food behaviour and lifestyle. The country would benefit from investing in four policy interventions to reduce the risk of behavioural risk factors such as tobacco consumption, alcohol consumption, an unhealthy diet, and physical inactivity. The 6th Country Cooperation Strategy (CCS) was devoted to 2022–2026, as well as WHO consultants and their nutrition plans. The objectives are sustainable development to control and continually prevent NCDs by improving the systems to implement national health policies and plans. *Conclusions.* Plant-based nutrition interventions are of the highest importance and essential in preventing NCDs. This review focuses on NCDs in Thailand and their risk factors, highlighting several prevention strategies through healthy nutrition and dietetics. The positive outcomes of the goals remain to be observed and challenged. If the control and prevention plan for NCDs in Thailand was effective and successful, this strategy could also be implemented in other countries.

Keywords: Nutrition, dietetics, plant-based diets, PBDs, prevention, risk of NCDs, non-communicable diseases, Thailand

INTRODUCTION

As of 2025, the population of Thailand is projected at 71.62 million, compared to 71.67 million in 2024. It ranks 20th in the world by population and 11th in Asia. The population growth rate in 2025 is projected at -0.07 percent (1). Their average lifespan is 71.4 years. NCDs are the most prevalent killer disease among all deaths, and stroke is the most common cause in both sexes (2-3). NCDs can cause the population to suffer a significant economic burden, resulting in Thailand's estimated 1.6 trillion baht in 2019. NCDs not only have a human and health cost but also an economical cost. The loss is about 9.7% of its gross domestic product (GDP). These costs include 139 billion baht to treat NCDs (9%) and 1.5 trillion baht (91%) in decreased productivity due to capacity reduction. Some other Asian countries have also taken up their NCDs burden as an essential public health agenda (4).

NCDs are often associated with degenerative and aging periods. However, since NCDs can affect people across the lifespan without discriminating by age and sex, unfortunately, 86% of premature NCD deaths occurred in low- and middle-income households, with half of the deaths occurring in the age group 30–69 years. Premature deaths and reduced productivity occur when employees cannot fully function and must leave their workplace, resulting in a financial burden. Therefore, the detection, screening, treatment, and health care for all ages and populations by the government's preventive and control measures will be crucial in preventing NCDs and reducing their financial burden (5-7).

According to WHO, Thailand and other nations observed these increased NCDs during the industrialization and development of the country (6). The Royal Thai Government authorities have raised awareness of NCD prevention by starting the 5-Year National NCDs Prevention and Control Plan (2017-2021) followed by the 6th Country Cooperation Strategy (CCS) during 2022–2026 along with WHO's strategic vision and consultants. The 6th CCS strives to enhance the systems necessary to implement

*To whom correspondence should be addressed:
maitree.suttajit@gmail.com

national health policies, strategies, and plans and achieve national objectives under the Sustainable Development Goals (SDGs). The CCS must be informed by a country-driven approach and based on a review of the health situation in Thailand (8).

Globally, preventive nutrition and dietetics have an important role in the prevention of NCDs, however, they should be introduced at the appropriate time and with the appropriate methods. Nutrition and diets would have a positive impact on the reduction of public health spending. WHO is well-positioned to provide global nutrition education for NCD prevention and management. Nutrition education and the health workforce must be increasingly focused on and be the key to enhancing population health and wellbeing. A balanced diet, rich in essential nutrients, is essential to maintaining health and preventing nutritional diseases. One of the most effective ways to solve these issues is by utilizing public education, particularly in healthy nutrition and diets. This article will examine and focus on NCDs and their risk factors in Thailand and outline various common prevention strategies through healthy nutrition and dietetics (9-10).

METHODS

We systematically searched the PubMed database using a search term that included “plant-based diets” in combination with terms on “dietary intake, nutritional status, phytonutrients, control plan, dietetics, plant-based, NCDs, lifestyles, nutrition, prevention, Thailand, vegetarian, vegan, WHO”. Questions to be answered: What are the risks associated with NCDs? What measures can be taken to prevent NCDs and control them? We aimed to demonstrate how nutrition and dietetics could contribute to preventing and reducing the risk of NCDs in the Thai population through WHO policy, government management, and health-related organizations.

RESULTS

From our systematic literature search, we found a significant link between food, nutrition, diet, and NCDs. The World Cancer Research Fund International and the NCD Alliance highlight the importance of addressing NCDs through dietary patterns and nutritional status (11).

The Link between Food, Diets, Nutrition and NCDs

Foods, diets, and nutritional status are important factors contributing to the development of NCD. Unhealthy diets are detrimental to pathological conditions such as obesity, hypertension, CVDs, certain types of cancer, and type-2 diabetes.

Overweight is a dietary condition that is associated with excessive body fat. It increases the risk of heart disease, diabetes, and other health problems. Overweight and obesity, as well as dietary factors such as elevated blood pressure and blood cholesterol, are risk factors for NCDs and major causes of multiple illnesses (12). Approximately 80% of these individuals with NCDs were in low- and middle-income countries, with 29% affecting individuals under 60 years old (13-14).

Modern nutrition transition from traditional foods has dramatically altered the dietary patterns and nutrient intake, such as fiber-rich foods (whole grains, pulses, and roots) that have decreased, while higher caloric consumption from refined grains, sugars, animal meat, and fats has increased (15).

Many Thai modern dishes originate from traditional foreign dishes. Some examples of the Thai top dishes are “Pork grilled on pan” (Moo Kata, หมูกระทะ) which derives from Korean meat BBQ (Gogigoo-ui, Korean), and “Khao Man Gai” (ข้าวมันไก่) from Hainanese chicken rice, a dish that’s extremely popular among Thai youths and their families. Both cooked meats contain higher saturated fats and cholesterol. Over-grilled red meat and steak based on epidemiologic reports supporting the link between red and processed meats and increased colorectal cancer risk. Subsequently and socially, such regular and overeating behaviours become food addiction, probably causing obesity and gastric cancer in Thai adults. These habitual changes in foods and lifestyles in different populations with higher incomes contribute to NCDs by influencing the nutritional quality and imbalance of available foods (16).

WHO has implemented a worldwide response to NCDs, including recommendations for population-based strategies and monitoring frameworks with targets and indicators. The need for greater coordination between NCD prevention efforts and actions addressing unhealthy nutrition and food system challenges is essential. Nutritionists and dietitians contribute significantly to NCD prevention by promoting balanced nutrition, addressing risk factors, and advocating for healthier food systems. Their expertise is crucial for the fight against NCDs. The beneficial and possible outcomes of the strategies should be interesting to be challenged and explored (13-14).

What are the effects of NCDs and health issues in Thailand?

Today, NCDs, primarily heart disease, stroke, cancers, diabetes, and chronic lung diseases, account for 74% of deaths in Thailand, or 400,000 people each year. In Thailand, NCDs, such as heart disease, stroke, cancer, diabetes, and chronic lung disease, have five major risks: tobacco smoking, less physical activity, alcohol drinking, unhealthy diets, and air pollution. The risk factors of NCDs from cigarette smoking and alcohol consumption are significantly higher in the young population (24-54 years). Metabolic factors, such as hypertension, hypercholesterolemia, overweight and obesity, and type-2 diabetes, are found to increase in older adults (55–65 years) (17-19).

From the study of NCD prevalence and Social Determinants of Health (SDHs) in Thailand during 2013-2021, it was found that the prevalence rates of CVD and COPD were remarkably higher. The SDHs data included household income, expenses, loans, education, smokers, alcohol consumers, and air-polluted PM2.5 levels. Policy implications should include the need for interventions to raise awareness of risk factors and their consequences. Healthy lifestyles have to be improved. More effective policies are set to improve health equity. Preventive healthcare can be accessible to the public, regional disparities in healthcare infrastructure must be addressed, and investment in research was suggested that future research should be focused on interventions to reduce NCD prevalence and explore the cost-effectiveness of the strategies (20).

Nutrition-related diseases are caused by nutrient imbalances in the diet, either insufficient vitamins, minerals, and the optimal ratio of fatty acids (omega-3/omega-6 = 1/2) or high intake of calories and fats, as well as other nutritional issues. The primary cause of

NCDs is the excessive consumption of certain nutrients, saturated fats, high sodium, high calories, concentrated sugar, and sweet drinks, which are related to overweight, obesity, and type-2 diabetes. It revealed that a high intake of trans fats and cholesterol but low in essential unsaturated fats and natural antioxidants (polyphenols, flavonoids, carotenoids, and vitamins C and E, contributed to the increased incidence of atherosclerosis, cardiovascular heart disease (CVDs), Alzheimer's disease, and stroke. Excessive salt diets can increase the risk of hypertension and disorders of kidney function. The NCD's risk factors among the Thai population mostly involve increasing unhealthy or imbalanced nutrition and lifestyles. The behavioral changes rapidly raise CVDs, type-2 DM, cancers, COPD, obesity, hypertension, and kidney failure. Therefore, effective diet management by CCS and special nutritionists and dietitians is necessary for NCD prevention and control (20).

Roles of Nutritionists and Dietitians in NCD Prevention

Nutritionists and dietitians are food specialists who may present medical nutrition counselling and therapy. A nutritionist is an expert in food science and health. A dietitian specializes in promoting optimal health and preventing and regulating diseases through nutrition science. Dietitians are the only nutrition professionals who become legally regulated by law to be licensed as "Registered Dietitian Nutritionists" (RDN or RD) who help people understand the significance of healthy nutrition and how to improve their eating habits. Therefore, nutritionists and dietitians are essential in managing and preventing nutritional diseases by helping individuals create personalized meal plans for optimal and balanced diets. Dietitians also help physicians with conditions like kidney disease, diabetes, and heart disease. They should actively educate and encourage people of all ages to choose food properly to maintain their best weight and body mass index (BMI), medical situations, and good health. Dietitians work in various settings, including hospitals, clinics, public health care, nursing homes, academic and research laboratories, wellness centers, and spas (10, 21).

Urgent Need for Investment in NCDs

The WHO with the Ministry of Public Health of Thailand showed that the need to invest in NCDs is urgent. This will provide substantial social and economic expenses in the next decade. The analysis annually showed that. The Thai economy had a significant impact on NCDs, which cost 1.6 trillion THB or 9.7% of its 2019 gross domestic product (GDP) (4). A costing analysis provides an estimate of the cost required to implement a set of policy interventions for prevention and selected clinical interventions. A cost-benefit analysis compares these implementation costs to determine which intervention packages would provide the most advantageous returns on investment. The proposed evidence-based policy and clinical interventions would save 310,000 lives and generate THB 430 billion in benefits for the nation in the next 15 years (22-24).

The official documents also discuss other nutritional issues that may contribute to health and sustainable development. The policies and clinical interventions should be put together to represent critical and initial actions that can resolve the NCD

incidence in Thailand. The responsibility for these actions and the benefits that resulted is beyond the health sector to directly and indirectly impact the achievement of all the SDGs and impact the entire society. Dietitians are the only nutrition professionals to be regulated by law, and they are governed by an ethical code to ensure that they always adhere to the highest standards (22-23).

Thailand would benefit from investing in four policy intervention packages that reduce the risk of behavioral risk, including tobacco smoking, alcohol toxicity, improper diet and lifestyle, and physical inactivity. The primary clinical interventions for the most prevalent NCDs developed metabolic disorders utilizing a combination of prevention, early detection, and management strategies. Prevention strategies by implementing lifestyle changes to better health can significantly reduce the risk of NCDs. We urgently require early detection by regular health check-ups and screenings. These can help identify NCDs such as diabetes, CVDs, and cancers at an early stage making them easier to manage (22-23).

WHO has recently confirmed the appointment of Dr. Piroj Saonuan, M.D., Deputy CEO, Thai Health Promotion Foundation (ThaiHealth), as one of the 20 global experts in the control and prevention of NCDs in the Strategic and Technical Advisory Group on NCDs (STAG NCD), which provides academic expertise in essentially medicine. The Health Promotion Foundation Act established ThaiHealth as a government agency in 2001. "Everyone in Thailand has the capacity and lives in a society and environment conducive to good health," is their vision (25).

Roles of the Thai Ministry of Public Health in Reducing the Risk of NCDs

With the coordination with CCS and WHO Plan, Mr. Somsak Thepsutin, Minister of Health, chaired the first meeting of the National Salt and Sodium Consumption Reduction Policy Committee to Reduce NCDs. The Thai Ministry of Public Health is giving importance to solving the problem of NCDs, which are mainly caused by inappropriate eating behaviors, such as consuming too much salt and sodium. From the survey on salt consumption in Thailand in 2009, it was found that Thais consumed as much as 4.35 grams of sodium per person per day from their diet, which is twice as high as the WHO's limit of no more than 2 grams per day. Meanwhile, about 22 million Thais suffer from diseases related to sodium consumption, such as high blood pressure, kidney disease, heart disease, and CVDs.

Mr. Somsak already has a policy to reduce and prevent NCDs by assigning the Department of Disease Control to set up the working committee. The progress of the strategy to reduce salt and sodium consumption in Thailand from 2016-2025 has been reported, and policy issues have been pushed forward, with the goal of Thais having better health and staying away from NCDs. The committee should encourage Thais to reduce their salt consumption by at least 30%. The community health volunteers can use a tool called "Salt Mete" to raise awareness and control the amount of sodium in the cooking of responsible households, set a ceiling for salt and sodium in ready-to-eat food products, and push for financial measures such as a sodium tax law.

The Department of Disease Control is the main agency to strengthen the implementation of the strategy and action plan in formulating the strategy to

reduce salt and sodium consumption in Thailand (SALTS) to achieve the goals. The strategy for fiscal years 2017-2024 consists of two measures.

1. Creating, developing, and expanding a collaborative network by working with 2 network partners to expand the area of monitoring measures and reduce salt and sodium consumption nationwide.

2. Increasing knowledge, awareness, and enhancing skills of people, communities, producers/entrepreneurs, related professional personnel, and policymakers by publicizing health policies such as the policy to procure healthy food, the sodium tax policy, and setting a ceiling for sodium, and creating a social trend to reduce salt and sodium consumption through various channels (26).

Role of Thai Dietetics Association on NCDs Prevention

TDA was born in 1974, officially established in 1991, and joined the Federation of Dietetic Associations (AFDA). Since its establishment, TDA has been devoted to advancing the dietetics profession, promoting health through nutrition, and addressing key health issues such as NCDs. TDA has a significant role in preventing NCDs through various initiatives, journals, and programs, as well as educational programs and workshops to raise awareness about healthy eating habits and lifestyle choices that can prevent NCDs.

TDA has the authority to qualify and certify Thai dietitians and provide their Certificate of Dietetics of Thailand (CDT). Dietitians affiliated with TDA provide personalized nutrition counselling to assist individuals in managing their diet and reducing the risk of NCDs. TDA supports research on nutrition and NCDs and advocates for policies that promote healthy eating and reduce the prevalence of NCDs (27).

TDA organizes community outreach programs and annual nutrition and dietetic conferences to reach a wider audience and provide resources for healthy living. In these areas, overall TDA exemplifies to reduce the risks and burden of NCDs in Thailand and improve public health (22).

CONCLUSION

Like other developing countries in Asia, NCDs are the most prevalent deadly illness in Thailand and cause a deteriorating economic burden, resulting in a few trillion baht annually. The behaviour of unhealthy food consumption and lifestyle in the Thai population has played a significant role in deteriorating health outcomes for many for a few decades. Therefore, behaviour modification and lifestyle improvement should be priority strategies for healthcare organizations. The interventions should have a better

impact, resulting in valuable outcomes, if nutritionists and dieticians work collaborating with other professionals with different backgrounds and scopes of practice (28-29).

This review article on nutrition and dietetics for the prevention of NCDs would likely emphasize the critical role of dietary management in reducing the risk of NCDs. It would highlight the importance of a plant-based balanced diet rich in fruits, vegetables, whole grains, and lean proteins while minimizing the intake of meat-based diets, added sugars, unhealthy fats, and excessive salt. We would also stress the need for public awareness and education on healthy eating habits, as well as the role of healthcare professionals in guiding individuals towards better dietary choices. Additionally, it would call for comprehensive policies and programs to support healthy eating and physical activity at the community and national levels.

The interventions by lifestyle and behavioral changes in nutrition and dietetics through Thai governmental CCS policy and WHO guidelines and plan are urgently required in the reduction of the risk of NCDs to save the economic cost and national burdens (**Figure 1**). There are many problems and obstacles depending on the food business and consumers. They have to be regularly educated and behave with righteousness. If it were so done, these interventions should be able to effectively prevent or reduce NCDs in Thailand. How to do healthcare policy efficiency is a big question to be challenged.

Thoughts to be concerned about eating practice with mindfulness

A popular original phrase, *"Tell me what you eat, and I will tell you what you are,"* was said by Anthelme Brillat-Savarin in 1826 and by Ludwig Andreas Feuerbach in 1863-64 (30). The saying implies that the food we eat has a bearing on our mental and physical conditions. Our food choices can reduce NCD risks and profoundly impact our health and well-being. Some right thoughts may like these. Foods rich in omega-3 fatty acids help keep our brain memory. Whole grains, fruits, and vegetables help maintain good cardiovascular health. Prebiotics and probiotics in our food help promote beneficial bacteria and a healthy gut. Vitamin C-rich fruits can bolster our immune system. Dietary fiber helps bowel movements, regulates blood sugar and cholesterol, and supports weight management.

Before choosing and eating regular foods, we must think of, *"You are what and how you eat"*. After those foods were consumed, we must be more aware of our daily diets and which foods are influencing our health and wellness. Our thought must also be switched to *"You eat what and how you are"*.

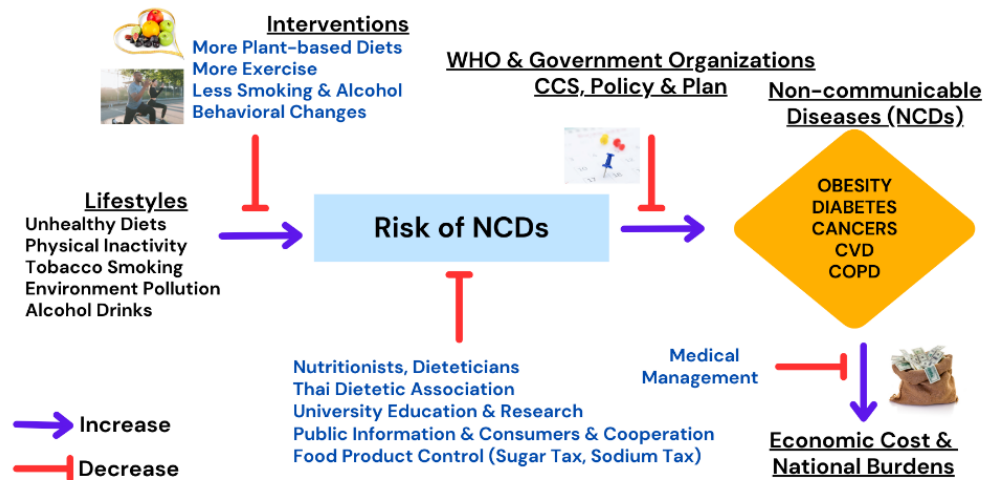


Figure 1. A model showing how interventions by lifestyle and behavioral changes of nutrition and dietetics reduce the risk of NCDs and save the economic cost and national burdens

REFERENCES

- World Population Prospects 2024 United Nations. <https://www.worldometers.info/>. Accessed February 25, 2025.
- Noncommunicable diseases country profiles 2018. Geneva: World Health Organization. https://www.who.int/nmh/countries/tha_en.pdf. Accessed February 25, 2025.
- Piovani D, Nikolopoulos GK, Bonovas S. Non-Communicable Diseases: The Invisible Epidemic. *J Clin Med*. 2022 Oct 8;11(19):5939.
- de Silva A, Varghese C, Amin MR, Bhagwat S S, Bruni A, Bunleusin S, Kaur J, de Silva P, Dorin FA, Dzed L, Giri B, Gunawardena N, Hanbanjerd K, Hudha F, Jeyakumaran D, Joshi P, Khaing AA, Lakshmanasamy R, Lethro P, Moe Lwin AM, Mallawarachchi V, Nieveras O, Nongynkrih B, Pramesh CS, Sinha P, Tenzin K, Wickramasinghe C, Pendse R. Non-communicable diseases in South-East Asia: journeying towards the SDG target. *Lancet Reg Health Southeast Asia*. 2023 Oct 29;18:100305.
- Bloom DE, Cafiero ET, Jané-Llopis E, Abrahams-Gessel S, Bloom LR, Fathima S et al. The global economic burden of non-communicable diseases. Geneva: World Economic Forum. http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNoncommunicableDiseases_2011.pdf. Accessed February 25, 2025.
- World Health Organization 2019 Prevention and Control of Noncommunicable Diseases in Thailand. https://uniatf.who.int/docs/librariesprovider22/default-document-library/thailand-ncd-report.pdf?sfvrsn=5a43be5c_2020. Accessed February 25, 2025.
- World Health Organization Thailand Cooperation Strategy 2022–2026. <https://www.who.int/publications/i/item/9789290210771>. Accessed February 25, 2025.
- Lepre B, Trigueiro H, Johnsen JT, Khalid AA, Ball L, Ray S. Global architecture for the nutrition training of health professionals: a scoping review and blueprint for next steps. *BMJ Nutr Prev Health*. 2022 Feb 16;5(1):106–117.
- Di Daniele N. The Role of Preventive Nutrition in Chronic Non-Communicable Diseases. *Nutrients*. 2019 May 15;11(5):1074.
- Al-Jawaldeh A, Abbass MMS. Unhealthy Dietary Habits and Obesity: The Major Risk Factors Beyond Non-Communicable Diseases in the Eastern Mediterranean Region. *Front Nutr*. 2022 Mar 16;9:817808.
- The link between food, nutrition, diet and non-communicable diseases. <https://www.wcrf.org/wp-content/uploads/2024/12/WCRF-NCD-A4-WEB.pdf>. Accessed February 25, 2025.
- Ndubuisi NE. Noncommunicable Diseases Prevention In Low- and Middle-Income Countries: An Overview of Health in All Policies (HiAP). *Inquiry*. 2021 Jan-Dec;58:46958020927885.
- Allotey P, Davey T, Reidpath DD. NCDs in low and middle-income countries - assessing the capacity of health systems to respond to population needs. *BMC Public Health*. 2014;14 Suppl 2(Suppl 2):S1.
- Mozaffarian D, Rosenberg I, Uauy R. History of modern nutrition science-implications for current research, dietary guidelines, and food policy. *BMJ*. 2018 Jun 13;361:k2392.
- NCD Alliance. Advocating for Health. <https://ncdalliance.org/why-ncds>. Accessed February 25, 2025.
- World Health Organization Data Thailand. <https://data.who.int/countries/764>. Accessed February 25, 2025.
- Rohmann N, Geese T, Nestel S, Schlicht K, Geisler C, Türk K, Brix F, Jensen-Kroll J, Demetrowitsch T, Bang C, Franke A, Lieb W, Schulte DM, Schwarz K, Ruß AK, Sharma A, Schreiber S, Dempfle A, Laudes M. Metabolic and lifestyle factors accelerate disease onset and alter gut microbiome in inflammatory non-communicable diseases. *BMC Med*. 2024 Oct 24;22(1):493.
- Suapumee N, Seeherunwong A, Wanitkun N, Chansatitporn N. Examining determinants of control of metabolic syndrome among older adults with NCDs receiving service at NCD Plus

- clinics: multilevel analysis. *BMC Health Serv Res.* 2024 Sep 27;24(1):1118.
- 19) Bhoothookngoan P, Sanchan N. Prevalence of Noncommunicable Diseases and Social Determinants of Health in Thailand: Insights from Public Datasets. *Thai Journal of Public Health.* 2024 Aug 29;54(2):918-36.
 - 20) Kimokoti RW, Millen BE. Nutrition for the Prevention of Chronic Diseases. *Med Clin North Am.* 2016 Nov;100(6):1185-1198.
 - 21) Muka T, Imo D, Jaspers L, Colpani V, Chaker L, van der Lee SJ, Mendis S, Chowdhury R, Bramer WM, Falla A, Pazoki R, Franco OH. The global impact of non-communicable diseases on healthcare spending and national income: a systematic review. *Eur J Epidemiol.* 2015 Apr;30(4):251-77.
 - 22) Global Insights to success, <https://sites.google.com/monash.edu/global-insights-to-success/home>. Accessed February 25, 2025.
 - 23) Prevention-and-control-noncommunicable-diseases-thailand-case-investment.html.<https://www.undp.org/thailand/publications/prevention-and-control-noncommunicable-diseases-thailand-and-case-investment>. Accessed February 25, 2025.
 - 24) Samaisong N. Dietary Management for Prevention and Reduction Risk of Non-communicable Diseases. *JRN-MHS [internet].* 2020 Dec. 26; 40(4):122-30. <https://he02.tci-thaijo.org/index.php/nur-psu/article/view/2469>
 07. Accessed February 25, 2025
 - 25) Dr.Pairoj has been appointed to be WHO STAG on NCDs. <https://www.who.int/thailand/news/detail/02-07-2024-dr.pairoj-has-been-appointed>. Accessed February 25, 2025.
 - 26) Kantachuvesiri S, Chailimpamontree W, Kunjang A, Chotipokasap N, Pomsanthia N, Raksaphet N, Saonuam P, Garg R. Mobilizing champions for sodium reduction in Thailand. *Lancet Reg Health Southeast Asia.* 2024 Apr 9;26:100406.
 - 27) Taechangam S, Pachotikarn C. Thai Dietetic Association: Celebrating the AFDA 30th Anniversary. *Asian Journal of Dietetics [internet].* 2021; 3(3): 81-85. https://jnl.calorie-smile.jp/eng/wordpress/wp-content/uploads/2021/09/asian_journal_of_dietetics_3_3_2021_81_85.pdf.
 - 28) Espinosa-Salas S, Gonzalez-Arias M. Behavior Modification for Lifestyle Improvement. 2023 Apr 23. In: *StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. PMID: 37276296.*
 - 29) Amerikanou C, Tzavara C, Kaliora AC. Dietary Patterns and Nutritional Value in Non-Communicable Diseases. *Nutrients.* 2023 Dec 26;16(1):82.
 - 30) Meanings you are what you eat.<https://www.phrases.org.uk/meanings/you-are-what-you-eat.html> Accessed February 25, 2025.

Original**Some of Gastrointestinal Functions Among Elderly at Aged Care Center in Hanoi, Vietnam: A Cross-Sectional Study**

Linh Thuy Nguyen^{1,2*}, Ha Ngoc Vu¹, Tuyet Chinh Thi Pham¹, Nga Thanh Ta¹, Hoang Thi Hai Yen³

¹Department of Nutrition and Dietetics, Ha Noi Medical University Hospital, Hanoi Medical University, Ha Noi, Viet Nam

²Department of Nutrition and Food Safety, School of Training Preventive Medicine and Public Health, Ha Noi Medical University, Ha Noi, Viet Nam

³Jumonji University

ABSTRACT: *Background and purpose.* Aging is associated with a decline in several physiological functions, including gastrointestinal function, that can affect the nutritional status and quality of life of individuals. *Method.* To assess the gastrointestinal function of older adults, a cross-sectional descriptive study was conducted in 100 participants, including assessment of their oral function and gastrointestinal symptoms. Additionally, a pilot study involving ultrasound assessment of gastric emptying in 20 older patients after drinking different fluids (formula, soup, and porridge) was conducted. *Results.* A decline in the oral function of older adults was observed, with 35% oral changes according to their OHAT scores. The participants were observed to not have large gastric volumes when fasting. After 2 hours of eating, the Gastric Volume (GV) after eating porridge were statistically larger than after consuming the semi-hydrolyzed soup (9.92 ± 13.97 ml vs 5.04 ± 22.55 ml). *Conclusion.* The faster gastric emptying for semi-hydrolyzed soup, compared to non-hydrolyzed liquid and semi-liquid, signifies that gastric emptying may be dependent on the nutrient content and density of the liquid.

Keywords: Aging, gastrointestinal symptoms, nutritional status, gastric volume, gastric emptying.

INTRODUCTION

Older adults make up a significant and rapidly increasing proportion of Vietnam's population. The percentage of Vietnamese aged 65 and older is projected to grow from 7.9% in 2020 to 16.3% of the population in 2040 (1). Aging is associated with a decline in several physiological functions, including dental and digestive health, that can impact the metabolic system, nutritional status, and daily routine. The digestive system is composed of the gastrointestinal (GI) tract or the alimentary canal, salivary glands, the liver, and the exocrine pancreas. As a result, the global burden of disease is increasing, as well as the burden of providing healthcare for older adults.

According to the World Dental Federation, impaired oral function is of great concern to global health, especially among the older population. A cross-sectional study conducted with 3220 Dutch nursing home residents showed that poor oral health, primarily problems with eating due to (artificial)

teeth problems, was associated with an almost twofold risk for malnutrition in older residents (2). Moreover, chewing difficulty is closely related to food and nutrient intake in older adults and can result in vitamin and mineral intake deficiencies (3).

GISs (Gastrointestinal Symptoms), which include nausea, vomiting, belching, abdominal pain, etc., frequently occur in older adults, as concluded in many studies (4,5). For example, a study conducted in Finland involving 3100 outpatients over 60 years old found that the overall prevalence of upper gastrointestinal symptoms was 43% (5). In addition, 90% of patients in another cross-sectional study in a clinically stable group of geriatric patients in Mexico had at least one GIS. Severe GIS values were associated with poorer nutritional status, as determined by the Malnutrition and Inflammation Score. Nonetheless, they had no association with anthropometry or biochemical value analysis (6).

Aging is associated with an increased prevalence of diseases associated with abnormally delayed gastric emptying (7). Some studies have

* To whom correspondence should be addressed:

linhngthuy@hmu.edu.vn

also described reductions involving liquid and solid emptying, particularly in individuals with low physical activity levels (8,9). The rate of gastric emptying of liquid is dependent on energy density and fat content. However, little is known about the effect of hydrolyzed liquid on gastric emptying time in the elderly. To determine the effect of aging on the gastric emptying, the previous studies have demonstrated that gastric ultrasonography provides valuable information for large gastric fluid volumes. In addition, ultrasonography is a noninvasive and safe tool to evaluate delayed gastric emptying while fasting and after eating in older adults (10,11).

In Vietnam, only a few studies assess the oral function, gastrointestinal symptoms, and gastric residual volume of older adults, especially outpatients in the community. For that reason, we performed this study with the aim of assessing the oral function and gastrointestinal symptoms of older adults at an elderly center in Hanoi, Vietnam. Moreover, our research aimed to clarify the effect of gastric emptying in elderly patients after drinking different fluids by ultrasound.

METHODS

Phase 1:

Design, setting, and sample

This study was a cross-sectional study to assess oral function and functional dyspepsia. It occurred from January to February 2023 in an aged care center with a capacity of 200 beds in the suburban area of Hanoi, Vietnam. At the time of the study, there were a total of 112 older adults who were residing in the center, and 100 of them were included according to the inclusion criteria: (i) age ≥ 60 years old, (ii) only have oral feeding, (iii) can understand to answer questions and (iv) agreed to join the study.

Data collection

Demographic data (such as gender and age) were collected from medical records, caregivers, and subjects.

Denture status assessment was carried out by the trained dietitians using the Oral Health Assessment Tool (OHAT) (12). The OHAT contains eight items relating to objective aspects of oral health: lips, tongue, gums and tissues, saliva, natural teeth, dentures, oral cleanliness, and dental pain. For each category, the examiner must score the seen condition on a three-level scale: 0=normal; 1=mild; 2= severe. Additionally, the number of lost teeth, the remaining natural teeth, and the usage and number of prosthetic dentures were collected.

Functional dyspepsia. Medical doctors used a questionnaire to ask the patients about the presence of functional dyspepsia (FD). The Rome IV criteria define dyspepsia as any combination of 4 symptoms: postprandial fullness, early satiety,

epigastric pain, and epigastric burning that are severe enough to interfere with the usual activities and occur at least 3 days per week over the last 3 months with an onset of at least 6 months in advance (13).

Phase 2:

Design, setting, and sample

In addition, to phase 1, pre-post pilot trial comparing the effect of different fluids on gastric emptying in elderly patients for the future direction of intervention was conducted in the same setting. Participants were screened using the inclusion criteria of being able to drink the liquid solution and agreeing to participate in the study. Patients with diabetes, enteral tube feeding, and a history of upper abdominal surgery including gastric surgery were excluded. In the end, 20 subjects were eligible to participate in the ultrasound assessment.

Procedure

The ultrasound procedures assessing the residual fluid after drinking fluid were performed nine times in 3 days by well-trained medical doctors. The 1st ultrasound was implemented before drinking the solution while the second and the third were after drinking 2 hours and 3 hours, accordingly. The subjects were required to fast overnight and drink 200 ml of liquid solution in the morning with day 1 using non-hydrolyzed formula, day 2 using semi-hydrolyzed soup, day 3 using the porridge.

Formula: 4.57 g protein, 3.69 g lipid, 14.81 g glucid, 110 kcal/ 100 ml

Semi - hydrolyzed soup (Fomeal Care soup): 5.8 g protein, 2.64 g lipid, 10.2 g glucid, 84 kcal/ 100 ml

Porridge was made by staffs of the kitchen at the aged care center: 4g protein, 2.9 g lipid, 10,0g glucid; 82 kcal/100ml.

Data collection

Ultrasound assessment of gastric volume. Patients were scanned in the right lateral decubitus position. We measured the antral cross-sectional area (CSA) using the technique described originally by Bolondi (14) and, subsequently, by Perlas et al. (15-17). Cross-sectional area (CSA) was calculated by using two perpendicular diameters – anteroposterior (AP) and craniocaudal (CC) and the formula for the area of an ellipse:

$$CSA = (AP \times CC \times \pi) / 4 \text{ with } \pi\text{-value} = 3.14.$$

Following ACSA computation, each subject's stomach total volume ("expected volume") was calculated using a mathematical model that has previously been examined and approved by other investigators:

$$GV \text{ (ml)} = 27.0 + 14.6 \times \text{right-lat CSA} - 1.28 \times \text{age}$$

Data processing

Data were analyzed by Stata 16.0 software. Data is cleaned before analysis. Data are presented as

n, %, mean \pm SD. The chi-square test and Fisher's exact test were used to compare proportional variables. Continuous variables were compared with paired t-tests for variables with normal distribution and paired Wilcoxon tests for abnormally distributed variables. A probability level of $p < 0.05$ was considered statistically significant. Univariate and multivariate logistic regression analyses were used to determine the relationship between dental and digestive conditions with other factors such as medical conditions and nutritional status.

RESULTS

Phase 1

The characteristics of 100 subjects and their association with oral function were demonstrated in Table 1. Most participants were older or equal to 75 years old (61%) as well as most were female (64%). Nearly half of the subjects had less than 20 natural teeth (45%) and oral changes (35%) according to OHAT scores. Based on the MNA-SF score, only 14% of participants were classified under the normal nutritional status group, 49% in the risk of malnutrition group, and 37% in the malnourished group. Moreover, elders with less than 20 natural teeth and oral changes have a significantly higher prevalence of being malnourished or at risk of being malnourished than ones that had more than 20 teeth and a healthy oral function group ($p=0.044$, $p=0.003$, respectively). By using univariate analysis, higher odds of having less than 20 natural teeth were

significantly associated with advancing age, people who were dependent or required some help for general function, dementia patients, malnutrition or at risk of malnutrition, and liquid or soft diet. Additionally, to the aforementioned factors, elderly who had more than 3 comorbidities, took more than 3 medicines, and had stayed at the nursing home more than 2 years were more likely to have poor oral function (oral changes) based on OHAT score. The associated factors to elderly functional dyspepsia are depicted in Table 2. Among 100 participants, 43% of them had functional dyspepsia (FD). Subjects with FD were 8.69 times (95% CI, 2.31 – 32.73) and 4.17 times (95% CI, 1.63 – 10.64) more likely to have gastrointestinal diseases and totally depend on others in everyday function than those without FD, respectively. **Phase 2**

Study 2 is a pre-post pilot trial conducted on 20 elderly people with an average age of 80.65 ± 9.19 years old, the youngest age is 70 years old, and the oldest age is 95 years old. There was no significant difference between the antral CSA of the three different liquids and food before and after 3 hours of consumption (Figure 1). However, after 2 hours of eating, the antral CSA and the gastric volume (GV) after eating porridge were statistically larger than after consuming the semi-hydrolyzed soup (4.96 ± 1.98 cm² vs 2.74 ± 0.99 cm² for CSA, and 9.92 ± 13.97 ml vs 5.04 ± 22.55 ml for GV; Table 3).

Table 4 indicated that there was no difference in the antral CSA after ingesting different liquid and semi-solid food and the participants' functional dyspepsia

Table 1. Characteristics of total Subjects (n, %) by oral function

Variable	All n = 100 (n, %)	Number of natural teeth			OR (95%CI)	4-16: oral changes n = 35 n (%)	OHAT 0-3: health n = 65 n (%)	OR (95%CI)
		< 20 teeth n = 45 n (%)	≥ 20 teeth n = 55 n (%)					
Age	≥ 75	61 (61.0)	34 (75.6)	27 (49.1)	3.21 (1.35 – 7.58)	23 (65.7)	38 (58.5)	1.36 (0.58 – 3.20)
	<75	39 (39.0)	11 (24.4)	28 (50.9)		12 (34.3)	27 (41.5)	
	<i>p</i>		0.007			0.478		
Gender	Male	36 (36.0)	13 (28.9)	23 (41.8)	0.57 (0.24 – 1.31)	14 (40.0)	22 (33.9)	1.3 (0.56 – 3.05)
	Female	64 (64.0)	32 (71.1)	32 (58.2)		21 (60.0)	43 (66.1)	
	<i>p</i>		0.18			0.541		
Comorbidities	≥ 3 diseases	22 (22.0)	11 (24.4)	11 (20.0)	1.29 (0.50 – 3.34)	10 (28.6)	8 (12.3)	2.85 (1.01 – 8.08)
	< 3 diseases	78 (78.0)	34 (75.6)	44 (80.0)		25 (71.4)	57 (87.7)	
	<i>p</i>		0.594			0.043		
Medicines	>3 medicines	31 (31.0)	14 (31.1)	17 (30.9)	1.01 (0.43 – 2.37)	16 (45.7)	15 (23.1)	2.81 (1.16 – 6.77)
	≤ 3 medicines	69 (69.0)	31 (68.9)	38 (69.1)		19 (54.3)	50 (76.9)	
	<i>p</i>		0.983			0.02		
Length of stay in nursing home	< 2 years	44 (44.0)	17 (37.8)	27 (49.1)	0.59 (0.26 – 1.31)	10 (28.6)	35 (53.8)	0.34 (0.14 – 0.83)
	≥ 2 years	56 (56.0)	28 (62.2)	28 (50.1)		25 (71.4)	30 (46.2)	
	<i>p</i>		0.257			0.015		
General functional status	Totally dependent	43 (43.0)	26 (57.8)	17 (30.9)	1.00	26 (74.3)	17 (26.1)	1.00
	Requires some help	17 (17.0)	8 (17.8)	9 (16.4)	1.72 (0.55 – 5.34)	2 (5.7)	15 (23.1)	11.47 (2.32 – 56.65)
	Independent	40 (40.0)	11 (24.4)	29 (52.7)	4.03 (1.60 – 10.17)	7 (20.0)	33 (50.8)	7.21 (2.60 – 19.98)
<i>p</i>		0.01			0.000			
Dementia	Yes	64 (64.0)	35 (77.8)	29 (52.7)	3.14 (1.30 – 7.56)	28 (80.0)	36 (55.4)	3.22 (1.23 – 8.43)
	No	36 (36.0)	10 (22.2)	26 (47.3)		7 (20.0)	29 (44.6)	
	<i>p</i>		0.009			0.014		
Malnutrition (MNA-	Malnutrition	37 (37.0)	19 (42.2)	18 (32.7)	1.00	20 (57.1)	17 (26.2)	1.00

Variable	All n = 100 (n, %)	Number of natural teeth			OR (95%CI)	4-16: oral changes n = 35 n (%)	OHAT 0-3: health n = 65 n (%)	OR (95%CI)
		< 20 teeth n = 45 n (%)	≥ 20 teeth n = 55 n (%)					
SF)	Risk of malnutritio n	49 (49.0)	24 (53.3)	25 (45.5)	1.1 (0.47 – 2.58)	14 (40.0)	35 (53.8)	2.94 (1.20 – 7.20)
	Normal	14 (14.0)	2 (4.5)	12 (21.8)	6.33 (1.24 – 32.32)	1 (2.9)	13 (20.0)	15.29 (1.81 – 129.25)
	<i>p</i>		0.044			0.003		
Food's texture	Liquid	19 (19.0)	13 (28.9)	6 (10.9)	1.00	7 (10.8)	12 (34.3)	1.00
	Soft and small	16 (16.0)	9 (20.0)	7 (12.7)	1.69 (0.42 – 6.71)	11 (16.9)	5 (14.3)	0.27 (0.06 – 1.09)
	Normal	65 (65.0)	23 (51.1)	42 (76.4)	3.96 (1.33 – 11.8)	47 (72.3)	18 (51.4)	0.22 (0.08 – 0.66)
<i>p</i>		0.024			0.016			

Table 2. Characteristics of total subjects (n, %) by functional dyspepsia

Variable	All participants n = 100 (n, %)	Functional dyspepsia (FD)			
		Have n (%)	Do not have n (%)	OR (95%CI)	
Age	≥ 75	61 (61.0)	29 (47.5)	32 (52.5)	1.62 (0.71 – 3.69)
	<75	39 (39.0)	14 (35.9)	25 (64.1)	
	<i>p</i>		0.251		
Gender	Male	36 (36.0)	16 (44.4)	20 (55.6)	1.10 (0.48 – 2.50)
	Female	64 (64.0)	27 (42.2)	37 (57.8)	
	<i>p</i>		0.827		
Comorbidities	≥ 3 diseases	22 (22.0)	11 (50.0)	11 (50.0)	1.44 (0.56 – 3.72)
	< 3 diseases	78 (78.0)	32 (41.0)	46 (59.0)	
	<i>p</i>		0.453		
Gastrointestinal diseases	Yes	17 (17.0)	14 (82.4)	3 (17.6)	8.69 (2.31 – 32.73)
	No	83 (83.0)	29 (34.9)	54 (65.1)	
	<i>p</i>		0.000		
Medicines	>3 medicines	31 (31.0)	13 (41.9)	18 (58.1)	0.94 (0.40 – 2.21)
	≤ 3 medicines	69 (69.0)	30 (43.5)	39 (56.5)	
	<i>p</i>		0.885		
Length of stay in nursing home	< 2 years	44 (44.0)	17 (38.6)	27 (61.4)	0.73 (0.33 – 1.62)
	≥ 2 years	56 (56.0)	26 (46.4)	30 (53.6)	
	<i>p</i>		0.435		
General functional status	Totally dependent	43 (43.0)	25 (58.1)	18 (41.9)	1.56 (0.51 – 4.83)
	Requires some help	17 (17.0)	8 (47.1)	9 (52.9)	
	Independent	40 (40.0)	10 (25.0)	30 (75.0)	4.17 (1.63 – 10.64)
<i>p</i>		0.009			
Malnutrition (MNA-SF)	Malnutrition	37 (37.0)	16 (43.2)	21 (56.8)	1.00 0.86 (0.36 – 2.03)
	Risk of malnutrition	49 (49.0)	23 (46.9)	26 (53.1)	
	Normal	14 (14.0)	4 (28.6)	10 (71.4)	1.90 (0.50 – 7.20)
<i>p</i>		0.472			
Food's texture	Liquid	19 (19.0)	10 (52.6)	9 (47.4)	1.00 3.33 (0.78 – 14.16)
	Soft and small	16 (16.0)	4 (25.0)	12 (75.0)	
	Normal	65 (65.0)	29 (44.6)	36 (55.4)	1.38 (0.50 – 3.84)
<i>p</i>		0.234			

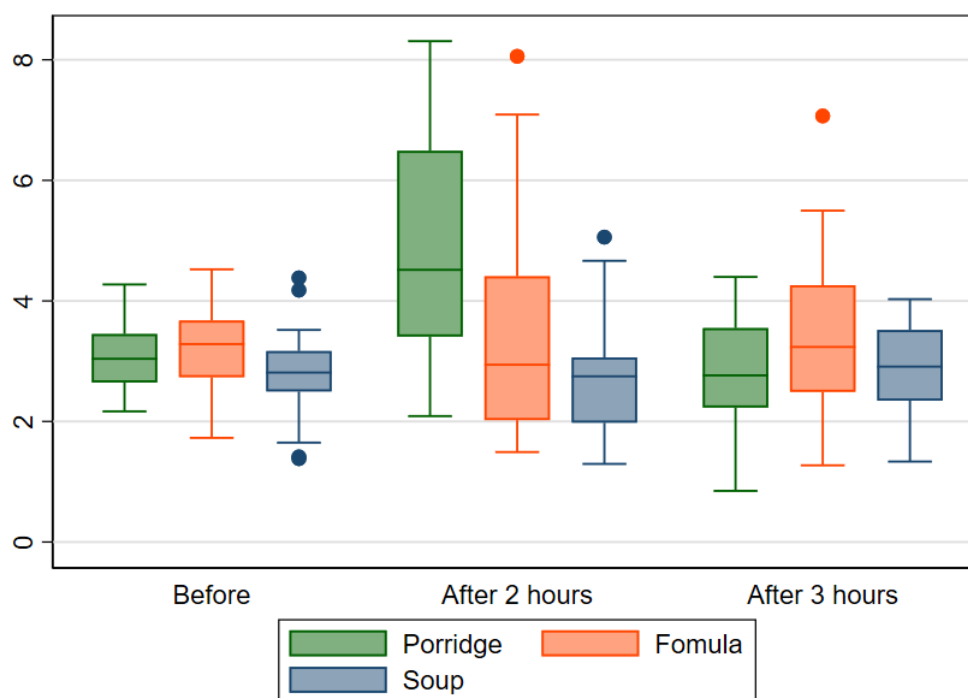


Figure 1. The evaluation of antral CSA between the porridge, formula, and soup groups

Table 3. Comparative ultrasound assessment of gastric emptying between liquid and semi-solid food in elderly patients

Time		Formula	Hydrolyzed soup	Porridge	p-value		
					Formula vs Soup	Porridge vs Soup	Porridge vs Formula
Before eating	CSA (cm ²)	3.22 ± 0.72	2.79 ± 0.77	3.12 ± 0.62	0.084	0.130	0.447
	Gastric volume (ml)	0	0	0			
After eating 2 hours	CSA (cm ²)	3.46 ± 1.96	2.74 ± 0.99	4.96 ± 1.98	0.136	0.000	0.067
	Gastric volume (ml)	25.03 ± 52.04	5.04 ± 22.55	9.92 ± 13.97	0.375	0.032	0.515
After eating 3 hours	CSA (cm ²)	3.46 ± 1.40	2.90 ± 0.74	2.81 ± 0.88	0.069	0.740	0.129
	Gastric volume (ml)	11.87 ± 36.73	0	0.08 ± 0.36	0.500	0.317	0.524

*CSA=Antral cross-sectional area; FD=Functional dyspepsia

Table 4. Participants' antral cross-sectional area by their functional dyspepsia (n=20)

	CSA (cm ²) Mean ± SD	FD (n = 9)	No FD (n=11)	P
After eating 2 hours	Formula	3.24 ± 1.74	3.64 ± 2.19	0.659
	Soup	2.60 ± 0.59	2.85 ± 1.25	0.597
	Porridge	4.38 ± 1.80	5.43 ± 2.07	0.247
After eating 3 hours	Formula	3.45 ± 1.70	3.48 ± 1.18	0.968
	Soup	2.84 ± 0.61	2.95 ± 0.86	0.752
	Porridge	2.52 ± 0.99	3.06 ± 0.73	0.176

*CSA=Antral cross-sectional area; FD=Functional dyspepsia

DISCUSSION

A cohort study of 36,283 Chinese older adults suggested that compared to those with 20+ teeth, tooth loss was associated with a gradual increase in mortality (18). This study elucidated that the prevalence of elderly having 0-19 natural teeth was 45%, which indicated that it is also a concerning problem in Vietnam, given its rapid increment of aging population. In addition, 50.9% of older adults aged 60–75 have 20 or more natural teeth, which is slightly lower than the 2008 Korean National Health and Nutrition Examination Survey with a prevalence of 53.6% (19). Furthermore, within the older than 75 years of age population, the same indicator was 49.1%, also lower than Japan's report in 2016 which was 51.2% (20).

The oral hygiene and health of the institutionalized elderly are frequently described as inadequate. Bad oral hygiene and health have often been reported (21). According to OHAT, our research reported that the proportion of older adults having a healthy oral score was 65%. This prevalence is 2 times higher than the result of Siyue Liu and et.al.'s study on 1280 individuals from nursing homes in China (2023) with only 28.5% of residents having a healthy mouth, and 71.5% showing changes requiring monitoring and an unhealthy mouth giving cause for concern (22). This divergence may come from the difference in the residences of the nursing homes in each study. Moreover, both studies found that there was a correlation between the number of intake medicines and OHAT scores in Liu's study 43.2% had to take more than 5 medicines while in our study only 31% took more than 3 medicines.

Additionally, our study also revealed an association between oral health and malnutrition in Vietnamese older adults in nursing homes. This result is in consensus with several review articles that have been published before on the association between oral health and nutritional status (23-25). According to an epidemiological study, having more than 20 natural teeth is ideal for maintaining a balanced diet (26). Poor oral functions such as decreased ability to chew and swallow lead to

unfavorable changes in food choices and a poor quantity and quality of food intake among older adults. Inadequate dietary intake is a risk factor for malnutrition. Thus, it is important to give dietary counseling to improve dietary intake and nutritional status in older persons with tooth loss (27).

Not only oral function but aging also affects all functions of the gastrointestinal system such as motility, digestion, and absorption. Functional dyspepsia may be harder to detect and treat in older adults since common gastrointestinal diseases might resemble illnesses in the elderly. Our study was one of the first studies to evaluate the prevalence of FD in institutionalized elders in Vietnam with 43%, higher than the results of other studies. The most recent study on the worldwide prevalence of uninvestigated dyspepsia showed a pooled value of 21% (95% CI, 18-24%); meanwhile, in a national survey in Korea, the prevalence of FD at ≥ 60 years was 11% (28, 29).

In our study, liquids and digestible semi liquid are emptied in the digestive period that lasts 2-3 hours after a meal. Similarly, the studies in different populations demonstrated that carbohydrate drinks were emptied after 2 hours of the last ingestion.

After 3 hours, the gastric volume is 0ml in 100% of the participant's soup ingested. These results demonstrate the rapid gastric emptying time of hydrolyzed liquid compared to non-hydrolyzed liquid and semi liquid solid. Yasuyuki demonstrated that the delaying effect of lipid on gastric emptying is accentuated in the elderly (30). In addition, the rate of gastric emptying responses to feeding with protein solutions are independent of the degree of protein fractionation (31). Therefore, in our study, the rapid gastric emptying of semi-hydrolyzed soup maybe related to the low content fat and low density calorie liquid.

In our study, gastric volume was calculated using the formula developed from a prior study performed in a different patient population. Therefore, the result may differ from our patients' actual gastric volume.

However antral CSA in the soup group was smaller than in the formula group. Lionel Bouvet et

al. suggest interest in estimating that a single ultrasonographic measurement of the antral area could be of preoperative gastric contents status (32). Moreover, measurement of the antral area is simpler, even if probably less accurate, than the assessment of antropyloric volume. Hence, repeated measurements of antral area are widely used for assessing gastric emptying time in diabetic and dyspeptic patients and for clinical research in obstetrical anaesthesia (14, 33). However, the cut-off value of CSA probably varies according to the age and height of patients (34).

This study has several limitations. Firstly, gastric volume was calculated using the formula developed from a prior study performed in a different patient population. Second, the gastric ultrasound requires a certain amount of training periods to ensure the results of assessments. Thirdly, a considerable number of the patients in our study do not have the ability to answer questions themselves. Thus, there is a possibility of bias caused by the answering of the carers. Fourthly, there is also a possibility of sampling bias and participation bias as the sample does not represent older Vietnamese adults.

In conclusion, the oral function of the geriatric population is generally deficient with an elevated prevalence of tooth loss. The proportion of functional dyspepsia in older adults was fairly high, affecting the quality of patients' lives. Participants do not have large gastric volumes in fasting in all group. The faster gastric emptying for semi-hydrolyzed soup compared to non-hydrolyzed liquid and semi liquid signifies that gastric emptying may be dependent on nutrient content and density of liquid. The antral CSA after ingesting different liquid and semi-solid food are independent of the participants' functional dyspepsia.

ACKNOWLEDGEMENT

We would like to express our sincere thanks to Hanoi Medical University Hospital and Tuyet Thai Age Care Center for facilitating the research progress. We also would like to give special thanks to Dr. Yamada and the company Orgalife for supporting the study. We would like to thank the patients who participated in the study.

REFERENCES

- 1) Vietnam: aging population forecast 2015-2040 Statista Available at: <https://www.statista.com/statistics/713671/vietnam-forecast-aging-population/>.
- 2) Viviënne A.L. Huppertz. Gert-Jan van der Putten. Ruud J.G. Halfens. Jos M.G.A.Schols. Lisette C.P.G.M.de Groot. 2017. Association Between Malnutrition and Oral Health in Dutch

- Nursing Home Residents: Results of the LPZ Study.
- 3) Song Hee Kwon. Hae Ryun Park. Young Mi Lee. Soo Youn Kwon. Ok Sun Kim. Hee Young Kim. Young Suk Lim. 2017. Difference in food and nutrient intakes in Korean elderly people according to chewing difficulty: using data from the Korea National Health and Nutrition Examination Survey 2013. *Nutrition Research and Practice*: 139-146.
- 4) L. Kay. 1994. Prevalence. Incidence and Prognosis of Gastrointestinal Symptoms in a Random Sample of an Elderly Population. *Age and Ageing*: 146-149.
- 5) Alberto Pilotto. Stefania Maggi. Marianna Noale. Marilisa Franceschi. Giancarlo Parisi. Gaetano Crepaldi. 2011. Association of upper gastrointestinal symptoms with functional and clinical characteristics in elderly.
- 6) Dinorah Carrera-Jiménez. Paola Miranda-Alatriste. Ximena Atilano-Carsi. Ricardo Correa-Rotter. Ángeles Espinosa-Cuevas. 2018. Relationship between Nutritional Status and Gastrointestinal Symptoms in Geriatric Patients with End-Stage Renal Disease on Dialysis. *Nutr*: 10(4). 425.
- 7) Stijn Soenen et al. Gastric Emptying in the Elderly. *Clin Geriatr Med* (2015)
- 8) Kao CH. Lai TL. Wang SJ. Chen GH. Yeh SH. Influence of age on gastric emptying in healthy Chinese. *Clin Nucl Med* 1994; 19 (5): 401-4.
- 9) Nakae Y. Onouchi H. Kagaya M. Kondo T. Effects of aging and gastric lipolysis on gastric emptying of lipid in liquid meal. *J Gastroenterol* 1999; 34 (4): 445-9.
- 10) Van de Putte P. Perlas A. Ultrasound assessment of gastric content and volume. *Br J Anaesth*. 2014;113:12–22.
- 11) Bouvet L. Mazoit JX. Chassard D. Allaouchiche B. Boselli E. Benhamou D. Clinical assessment of the ultrasonographic measurement of antral area for estimating preoperative gastric content and volume. *Anesthesiology*. 2011;114:1086–1092.
- 12) Chalmers JM, King PL, Spencer AJ, Wright FA, Carter KD. The oral health assessment tool--validity and reliability. *Aust Dent J*. 2005 Sep;50(3):191-9.
- 13) Stanghellini V, Chan FK, Hasler WL, Malagelada JR, Suzuki H, Tack J, Talley NJ: Gastrointestinal disorders. *Gastroenterology* 2016; 150: 1380–1392.
- 14) Bolondi L. Bortolotti M. Santi V. et al. Measurement of gastric emptying time by real-time ultrasonography. *Gastroenterology*. 1985;80:752-9
- 15) Perlas A. Davis L. Khan M. et al. Gastric sonography in the fasted surgical patient: a

- prospective descriptive study. *Anesth Analg.* 2011;113:93-7.
- 16) Perlas A, Chan VW, Lupu CM, et al. Ultrasound assessment of gastric content and volume. *Anesthesiology.* 2009;111:82-9.
 - 17) Perlas AM, Nicholas M, Lui L, et al. Validation of a mathematical model of ultrasound-determined gastric volume by gastroscopic examination. *Anesth Analg.* 2013;116:357-63.
 - 18) Yuan, JQ., Lv, YB., Kraus, V.B. et al. Number of natural teeth, denture use and mortality in Chinese elderly: a population-based prospective cohort study. *BMC Oral Health* 20, 100 (2020).
 - 19) Yun-Sook Jung, Taejun Park, et al. Influence of Chewing Ability on Elderly Adults' Cognitive Functioning: The Mediating Effects of the Ability to Perform Daily Life Activities and Nutritional Status. *Int J Environ Res Public Health.* 2022 Feb; 19(3): 1236.
 - 20) Hiroko Miura, Rumi Tano, Recent measures in geriatric oral health care in Japan, *Journal of the National Institute of Public Health*, 2019, Volume 68, Issue 1, Pages 8-16.
 - 21) Luc M. De Visschere Oral hygiene of elderly people in long-term care institutions – a cross-sectional study. *Gerodontology* 2006; 23: 195–204
 - 22) Liu, S., Guo, Y., Hu, Z. et al. Association of oral status with frailty among older adults in nursing homes: a cross-sectional study. *BMC Oral Health* 23, 368 (2023).
 - 23) Van Lancker A., Verhaeghe S., Van Hecke A., Vanderwee K., Goossens J., Beekman D. The association between malnutrition and oral health status in elderly in long-term care facilities: a systematic review. *Int J Nurs Stud.* 2012;49:1568–1581.
 - 24) Toniazzo M.P., Amorim P.S., Muniz F., Weidlich P. Relationship of nutritional status and oral health in elderly: systematic review with meta-analysis. *Clin Nutr.* 2018;37:824–830.
 - 25) Iwasaki M, Hirano H, Ohara Y, Motokawa K. The association of oral function with dietary intake and nutritional status among older adults: Latest evidence from epidemiological studies. *Jpn Dent Sci Rev.* 2021 Nov;57:128-137.
 - 26) Yoshihara A, Watanabe R, Nishimuta M, Hanada N, Miyazaki H. The relationship between dietary intake and the number of teeth in elderly Japanese subjects. *Gerodontology.* 2005 Dec;22(4):211-8.
 - 27) Iwasaki M, Hirano H, Ohara Y, Motokawa K. The association of oral function with dietary intake and nutritional status among older adults: Latest evidence from epidemiological studies. *Jpn Dent Sci Rev.* 2021 Nov;57:128-137.
 - 28) Ford AC, Marwaha A, Sood R, Moayyedi P. Global prevalence of, and risk factors for, uninvestigated dyspepsia: a meta-analysis. *Gut.* 2015;64(7):1049–57.
 - 29) Kim SE, Kim N, Lee JY, Park KS, Shin JE, Nam K, et al. Prevalence and risk factors of functional dyspepsia in health check-up population: a nationwide multicenter prospective study. *J Neurogastroenterol Motil.* 2018;24(4):603–13.
 - 30) Yasuyuki N. et al. Effect of aging lipolysis on gastric emptying of lipid in liquid meal. *K Gastroenterol* 1999; 34: 445-449
 - 31) Gastric emptying, gastric secretion and enterogastrone response after administration of milk proteins or their peptide hydrolysates in human. *Eur J Nutri* (2004) 43: 127-139
 - 32) Bouvet L, Miquel A, Chassard D, Boselli E, Allaouchiche B, Benhamou D. Could a single standardized ultrasonographic measurement of antral area be of interest for assessing gastric contents? A preliminary report. *Eur J Anaesthesiol* 2009;26:1015–9.
 - 33) Darwiche G, Almer LO, Bjorgell O, et al. Measurement of gastric emptying by standardized real-time ultrasonography in healthy subjects and diabetic patients. *J Ultrasound Med* 1999; 18:673–682.
 - 34) Perlas A, Chan VW, Lupu CM, et al. Ultrasound assessment of gastric content and volume. *Anesthesiology* 2009; 111:82–89.

Original**Nutrition teacher's class in elementary school and dietary pattern in adolescence**Tohru Kobayashi^{1*}, and Eisaku Okada²*¹Department of Food Science and Human Wellness, Rakuno Gakuen University, Ebetsu, Hokkaido, Japan**²Faculty of Social Policy and Administration, Hosei University, Machida, Tokyo, Japan.*

ABSTRACT *Background and purpose.* The association between the experience of nutrition teacher's class (NTC) during elementary school and dietary pattern in adolescence remains unclear. This study aimed to explore the association between receiving a nutrition teacher's class (NTC) during elementary school and dietary patterns in adolescence. *Methods.* This study participants were one high school students comprising 352 boys and 321 girls recruited between May and July 2020. Data on the experience of receiving NTC and individual characteristics were obtained using self-administered questionnaires. Dietary intake data were obtained using a validated brief-type self-administered diet history questionnaire for elementary to high-school-age students (BDHQ15y). Dietary patterns were identified using principal component analysis with varimax rotation performed using 67 food and beverages items from the BDHQ15y stratified by sex. Multiple logistic regression analysis ($p < 0.05$) was used to analyze the proportion of high dietary pattern scores more than 75 percentile based on the experience of receiving NTC. *Result.* After adjusting potential confounding factors, among the students who received NTC, the odds ratio (OR) of a high score of healthy Japanese dietary pattern in boys was 1.85 (95% confidence interval, 1.09–3.15), and that of the snack foods pattern in girls was 0.52 (95% confidence interval, 0.31–0.90) compared with those who did not receive NTC. *Conclusion.* Receiving NTC during elementary school may improve dietary patterns in adolescence.

Keywords: nutrition education, high school students, dietary habit, epidemiology, dietary habit

INTRODUCTION

Nutrition education aims to improve dietary habits, behaviors, nutrition literacy, and lifestyle, contributing to human health. In particular, nutrition education has been counteracting health problems such as overweight and obesity in

elementary school-age students.¹ Therefore, the nutrition education program has been increasingly adopted in the school curricula worldwide.²⁻⁶

A previous interventional study reported that nutrition education classes and farm tours increase knowledge of vitamins and minerals and

* To whom correspondence should be addressed:

tkoba@rakuno.ac.jp

improve vegetable consumption behavior among elementary school students.⁷ Another interventional study suggested that both lecture- and experience-based nutrition education methods improved dietary habits and nutritional knowledge among elementary school students after being followed.⁸ In addition, nutrition education interventions for elementary school students and their parents have improved their nutrition label literacy.⁹ However, the above evidence indicates a short-term positive effect of nutrition education on students. Although an interventional study with 1-year follow-up revealed that nutrition education positively affects body mass index (BMI),¹⁰ limited long-term studies exist.

In Japan, nutrition education has been called “Shokuiku,” and the Basic Act on Shokuiku (Food and Nutrition Education) was established in 2005.¹¹ Shokuiku mainly targets primary and middle school students to obtain knowledge of and ability to choose appropriate food and nutrition through their experiences that aim to develop children’s cultivation of humanity and acquisition of life skills. To enhance school-based Shokuiku programs, the Diet and Nutrition Teacher System was established in April 2007² and has been conducted in Japan since then. An interventional study in Japanese elementary schools indicated that a school-based nutrition education program, including a 45-minute lecture and homework, increased the knowledge level among students.¹² Moreover, one cross-sectional study suggested that people who received nutrition education at elementary and middle school tended to have a more positive attitude toward nutrition education.¹³ However, the effect of nutrition education during elementary school age on dietary patterns in adolescence remains unclear.

Systematic reviews have reported that unhealthy dietary patterns during childhood and

adolescence are related to the risk of cardiometabolic alterations,^{14,15} waist circumference, blood pressure,¹⁴ and higher levels of several pro-inflammatory biomarkers.¹⁶ Therefore, improving unhealthy dietary patterns during childhood and adolescence is important to future health outcomes. Providing nutrition education during elementary school days may be a beneficial strategy for establishing good dietary patterns in adulthood. This study thus aims to explore the association between the experience of receiving nutrition education from nutrition teachers in elementary school and dietary patterns in adolescence among Japanese high school students.

METHODS

Study Population

The students of 10th–12th grades in a private high school in Hokkaido, Japan, were recruited between May and July 2020 for this study. We administered a self-administered anonymous questionnaire and requested the participants to fill it out and return it via a class teacher. Questionnaires were filled out anonymously. We explained the purpose of the survey and obtained oral informed consent to the participants face-to-face in their classrooms. This study was conducted in accordance with the guidelines of the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of Rakuno Gakuen University (2020, No.20-2).

Data Collection and Measures

The question asked to the participants regarding their experience of nutrition teacher’s class (NTC) during elementary school was, “Did you receive nutrition education from nutrition teachers during elementary school?” The participants responded yes, no, or unknown. For lifestyle factors and individual characteristics, we recorded living arrangement (with family or dormitory), school club activity

(participating or not participating), frequency of breakfast (every day, 4–6 days/week, 2–3 days/week, or ≤ 1 day/week), and having anemia (yes or no). A previous scoping review reported that parental involvement is one of the dominant teaching strategies for nutrition education programs.¹⁷ Thus, participants were asked whether their parents are interested in “Shokuiku” by participants answering yes or no. A validated brief self-administered diet history questionnaire (BDHQ)¹⁸ was used to assess the preceding month’s dietary intake of elementary-to-high-school-age students (BDHQ15y) regarding the consumption frequency of 67 foods and beverages commonly consumed by the Japanese population. Total daily energy intake was calculated based on daily food intake information and the Japanese food composition table.¹⁹ We obtained the height and body weight data from participants who answered questions present in the BDHQ15y. Body mass index (BMI) was calculated as weight (kg) / height (m).²

Dietary Pattern

Dietary patterns were identified by principal component analysis with varimax rotation, which was performed using 67 food and beverages items from the BDHQ15y. Referring to previous studies using the BDHQ,²⁰⁻²² we applied dietary patterns by considering eigenvalues, scree plots, and extracted factor interpretability. Dietary pattern scores were calculated by summing the factor loadings weighted by daily food intake. Factor loadings indicated positive or negative associations with the dietary patterns. Food with a positive factor loading indicated a positive association with dietary patterns; conversely, food with a negative factor loading was negatively associated with dietary patterns. A high dietary pattern score indicated sufficient adherence to dietary patterns. Dietary patterns were analyzed according to sex.

Outcome Measures

We assessed the outcome measures using a high dietary pattern score. A high dietary pattern score was defined as 75 percentiles or higher scores in the distribution of each dietary pattern score.

Statistical Analyses

We categorized the distribution of lifestyle factors and individual characteristics based on the experience of receiving NTC in elementary school into two groups: no or unknown and yes. A logistic regression model was used to calculate the odds ratios (ORs) (95% confidence intervals (CIs)) of a high score of each dietary pattern scores based on the experience of receiving NTC after adjusting for potential confounding factors. We selected confounding factors using an analytical framework for a directed acyclic graph (DAG),²³ which applied a minimum adjustment model (Figure 1). The multivariable-adjusted model included grade, school club activity, anemia, and interesting to “Shokuiku” in parent. All analyses were performed using JMP Pro 12.1.0 software (SAS Institute Inc. Cary, NC, USA). The level of significance was set at $p < 0.05$.

RESULTS

A total of 826 individuals were eligible for study participation, and 764 participants (92.5%) returned the questionnaire. Of them, participants with missing data on height and body weight ($n = 14$), those with less than 600 kcal or 4,000 kcal or more of total energy intake ($n = 59$), and those who did not answer questions about their experience of receiving NTC during elementary school ($n = 18$) were excluded from this study. Thus, 673 participants (352 boys and 321 girls) were included in the final analysis.

The characteristics of the study participants, grouped based on their experience of receiving NTC in elementary school, are presented in Table 1. Regarding the experience of receiving NTC, 54.5%

were boys and 61.1% were girls. Among boys, those who had an experience of receiving NTC comprised a higher proportion of 10th-grade students, had breakfast every day, and had a lower participation proportion in school club activities than those who had not received NTC. Among girls who had an experience of receiving NTC, the prevalence of anemia was higher than that of those who had not received NTC.

Table 2 presents the factor loading matrix for the major dietary patterns among boys identified by principal component analysis. The first factor was a healthy Japanese dietary pattern characterized by a high intake of fish, diverse vegetables, mushrooms, seaweed, and soybean products such as natto and tofu. The second factor was the high intake of confectioneries, noodles, and fats such as butter and margarine, named as snack foods pattern. The third factor was the animal food pattern characterized by a high meat intake, such as chicken, pork, beef, yogurt, and cheese. The first to third dietary patterns accounted for 8.4, 5.8, and 4.8%, respectively, of the variance in food intake and explained 19.0% of the variability.

Table 3 presents the factor-loading matrix for

the major dietary patterns among girls identified by principal component analysis. The first and third factors of the snack foods pattern in girls represented similar results to the first and second factors of the healthy Japanese dietary pattern in boys. However, the second factor, named the Japanese breakfast pattern, is characterized by a high intake of eggs, soybean products, vegetable pickles, fruits, yogurt, and cheese. The first to third dietary patterns accounted for 8.1, 4.9, and 4.8%, respectively, of the variance in food intake and explained 17.8% of the variability.

Table 4 presents the ORs (95% CIs) for the proportion of a high-score group of each dietary pattern among boys and girls. Among boys, after adjusting for all related variables, the OR higher than the median value for healthy Japanese pattern score in those who had an experience of receiving NTC was 1.85 (95% CI, 1.09–1.85) compared with those who had not received NTC. Among girls, after adjusting for all related variables, the OR higher than median value for snack foods pattern score in those who had an experience of receiving NTC was 0.52 (95% CI, 0.31–0.90) compared with those who had not received NTC.

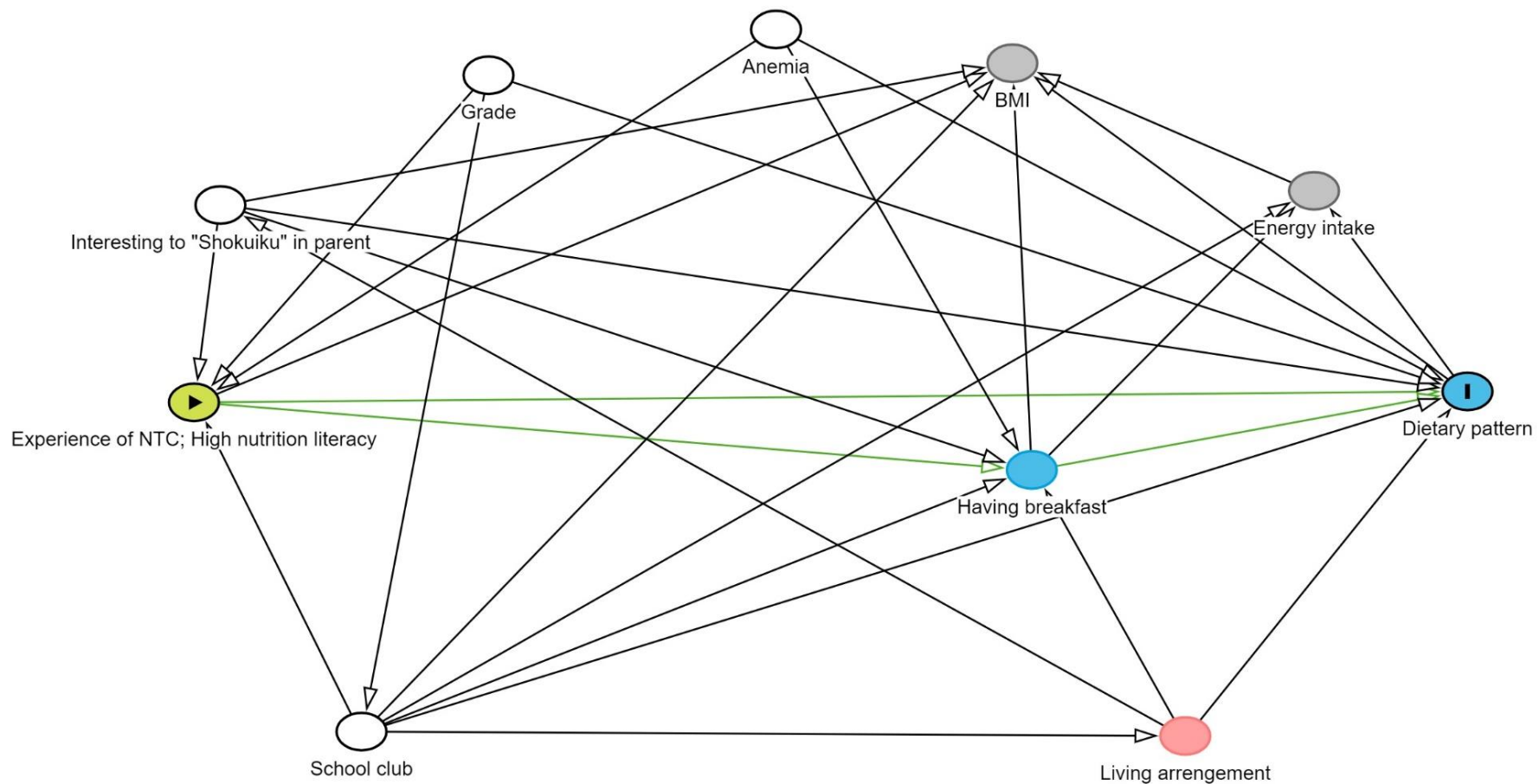


Figure 1. Analytical framework selected confounders using a DAG

NTC: Nutrition teacher's class; BMI: Body Mass Index;

Shokuiku: A common name the nutrition education in Japan

Table 1 Characteristics of the 673 high school students according to experience of received nutrition teacher's class during elementary school

		An experience of received NTC			
		Boys (n =352)		Girls (n = 321)	
		No or unknown	Yes	No or unknown	Yes
		n = 160	n = 192	n = 125	n = 196
Grade	10th	58 (36.3)	103 (53.7)	52 (41.6)	91 (46.4)
	11th	45 (58.1)	45 (23.4)	34 (27.2)	56 (28.6)
	12th	57 (35.6)	44 (22.9)	39 (31.2)	49 (25.0)
BMI (kg/m ²)	<18.5	20 (12.5)	29 (15.1)	14 (11.2)	22 (11.2)
	18.5~24.9	123 (76.9)	144 (75.0)	102 (81.6)	162 (82.7)
	≥25.0	17 (10.6)	19 (9.9)	9 (7.2)	12 (6.1)
Living arrangement	With family	117 (73.1)	136 (71.2)	83 (66.4)	134 (69.0)
	Dormitory	43 (26.9)	55 (28.8)	42 (33.6)	60 (30.9)
School club activity	Participating	69 (44.0)	65 (34.2)	47 (38.2)	87 (44.9)
	Not participating	88 (56.1)	125 (65.8)	76 (61.8)	107 (55.2)
Having breakfast	Everyday	80 (50.0)	112 (58.3)	71 (56.8)	107 (54.6)
	4-6 days/week	14 (8.8)	20 (10.4)	14 (11.2)	24 (12.2)
	2-3 days/week	34 (21.3)	26 (13.5)	15 (12.0)	34 (17.4)
	≤1 day/week	27 (16.9)	34 (17.7)	24 (19.2)	30 (15.3)
	Unknown	5 (3.1)	0 (0.0)	1 (0.8)	1 (0.5)
Anemia		19 (12.5)	17 (9.1)	14 (11.3)	39 (19.9)
Parents are interested in "Shokuiku"	Yes	107 (67.7)	126 (66.0)	88 (71.5)	137 (69.9)
	No	51 (32.3)	65 (34.0)	35 (28.5)	59 (30.1)

Data are mean and standard deviation or n (%).

NTC: Nutrition teacher's class

Table 2 Factor loading matrix for major dietary patterns identified by principal component analysis among boys

	Healthy Japanese	Snack foods	Animal foods
Chicken		-0.31	0.57
Pork and beef			0.59
Ham, sausages and bacon			0.64
Liver			0.26
Squid, octopus, shrimp and clam	0.40		
Small fish with bones	0.34		
Canned tuna	0.28		
Dried fish and salted fish	0.28		
Oily fish	0.42		
Non-oily fish	0.39		
Seafood paste products	0.30		
Eggs	0.38		
Tofu and tofu products	0.40		
Natto	0.35		
Salted green and yellow vegetable pickles	0.45		
Other salted vegetable pickles	0.34		
Raw cabbage and lettuce	0.51	-0.27	
Green leafy vegetables	0.60		
Cabbage	0.66		
Carrots and pumpkins	0.60		
Radishes and turnips	0.59		
Other root vegetables	0.57		
Boiled tomato and stewed tomato	0.34		
Mushrooms	0.60		
Seaweeds	0.51		
Cakes, cookies and biscuits		0.57	
Japanese sweets		0.54	
Rice crackers		0.49	
Ice cream	-0.28		0.54
Snacks made from wheat flour		0.61	
Chocolates		0.26	
Buckwheat noodles		0.27	
Japanese wheat noodles		0.26	
Chinese noodles		0.39	
Spaghetti and macaroni		0.33	
French fries and potato chips		0.49	
Potatoes	0.39		
Butter		0.46	
Margarine		0.40	
Rice		-0.49	-0.60
Miso soup	0.26	-0.28	-0.46
Yoghurt			0.43
Cheese			0.49
Water		-0.28	-0.26

Natto: Fermented soybeans; Tofu: Soyabean curd

Factor loadings less than ± 0.25 shown by a blank for simplicity.

Table 3 Factor loading matrix for major dietary patterns identified by principal component analysis among girls

	Healthy Japanese	Japanese breakfast	Snack foods
Pork and beef			0.28
Ham, sausages and bacon			0.43
Squid, octopus, shrimp and clam			0.30
Oily fish	0.32	-0.26	
Non-oily fish	0.28		
Seafood paste products			0.36
Eggs		0.50	
Tofu and tofu products	0.39	0.27	
Natto		0.41	
Salted green and yellow vegetable pick	0.33	0.31	
Other salted vegetable pickles	0.26		
Raw cabbage and lettuce	0.69		
Green leafy vegetables	0.71		
Cabbage	0.73		
Carrots and pumpkins	0.75		
Radishes and turnips	0.70		
Other root vegetables	0.56		
Boiled tomato and stewed tomato	0.33	0.27	
Mushrooms	0.53		
Seaweeds	0.55		
Cakes, cookies and biscuits		-0.47	
Snacks made from wheat flour		-0.46	0.32
Chocolates		-0.51	
Citrus fruit including oranges		0.32	
Strawberries, persimmons and kiwi fruit		0.53	
Other fruits		0.44	
Breads	-0.27		
Japanese wheat noodles			0.36
Chinese noodles			0.38
Spaghetti and macaroni			0.30
French fries and potatoe chips			0.40
Potatoes	0.34		
Butter			0.29
Mayonnaise			0.42
Tomato ketchup			0.29
Worcestershire sauce and soy sauce		0.29	0.33
Rice			-0.67
Miso soup			-0.38
Yoghurt		0.44	
Cheese		0.32	
Cola and sweetened soft drinks	-0.27		

Natto: Fermented soyabeans; Tofu: Soyabean curd

Factor loadings less than ± 0.25 shown by a blank for simplicity.

Table 4 Odds ratio and 95% confidence interval for proportion of each high dietary pattern scores according to experience of received nutrition teacher's class during elementary school*

	An experience of received NTC		<i>P</i>
	No or unknown	Yes	
Boys	n = 192	n = 160	
Healthy Japanese	1.00 (reference)	1.85 (1.09 – 3.15)	0.023
Snack foods	1.00 (reference)	1.05 (0.62 – 1.79)	0.849
Animal foods	1.00 (reference)	1.02 (0.61 – 1.70)	0.946
Girls	n = 196	n = 125	
Healthy Japanese	1.00 (reference)	1.19 (0.49 – 1.45)	0.533
Japanese breakfast	1.00 (reference)	1.23 (0.71 – 2.15)	0.456
Snack foods	1.00 (reference)	0.52 (0.31 – 0.90)	0.019

*A high dietary pattern scores was defined as 75 percentile or more in distribution of each dietary pattern score.

Adjusted for grade, school club activity, anemia and parents are interested in "Shokuiku"

NTC: Nutrition teacher's class

DISCUSSION

In the current study, we analyzed dietary patterns in adolescent high school students, grouped based on their experience of receiving NTC during elementary school. We observed that participants who received NTC exhibited higher scores for healthy Japanese dietary patterns among boys and lower scores for snack food patterns among girls than those who did not receive NTC. To the best of our knowledge, this is the first study to suggest an association between dietary patterns and the experience of receiving NTC in elementary school.

A previous study on Japanese university students suggested that those with experience receiving NTC during elementary school had a higher intake of vegetables and eggs than those who did not receive NTC,²⁴ which is similar to the results of the present study. However, few reports exist on the long-term effects of nutrition education on dietary patterns from school age to adolescence. A prospective study that underwent a 2-year follow-up indicated that

increased fruit and vegetable intake followed the nutrition education intervention among elementary school students.²⁵ In addition, a recent cohort study in the age range of 14 to 22 years reported that a defective dietary pattern established in adolescence may continue into young adulthood.²⁶ These studies support our findings.

The association between an experience of receiving NTC during elementary school and dietary patterns in this study showed different trends among boys and girls. A previous systematic review among adolescents reported that unhealthy dietary patterns characterized by energy-dense snacks, fatty foods, and animal foods are associated with a risk of overweight and obesity; conversely, healthy dietary patterns such as vegetables, fruits, and fish may reduce that risk.²⁷ Therefore, participants with experience of receiving NTC can be considered focusing on eating healthy foods, as seen among boys, and reducing snack foods, as observed in girls. In addition, a previous cross-sectional study suggested that girls tend to eat more

snacks while watching television than boys.²⁸ In the present study, despite girls having a higher intake of vegetables, fish, eggs, and confectioneries, and had a lower total energy intake than boys (Data not shown). Therefore, the gender difference observed in the association between the experience of receiving NTC and the dietary pattern is primarily the disparities in dietary behaviors and food preferences between boys and girls.

Primary and middle schools in Japan constitute 6,924 nutrition teachers,²⁹ accounting for approximately 24.0% of the assigned nutrition teachers. Schools in Japan still have the vacancy to assign more nutrition teachers. Therefore, the Japanese government need to promoting increased employment of nutrition teachers to enhance NTC, contributing to future health for Japanese and not only improving dietary patterns among primary and middle school students.

In the present study, notably, we have assessed dietary intake using BDHQ15y and estimated dietary patterns using principal component analysis. Dietary patterns determined by the factor-loading matrix of food items are useful for understanding the dietary characteristics of adolescents. We also detected dietary patterns stratified by sex, which assessed the characteristics of the association between NTC received during elementary school and dietary patterns in adolescence. Further, we adjusted for confounding factor characteristics of high school students, such as grade, living arrangement, and club activity. The present study survey had a high response rate of 92.5%, which is noteworthy. However, this study has some limitations. First, we only collected subjective data on whether the participants received NTC during elementary school; quantitative data regarding the NTC frequency and content were not obtained.

Therefore, we could not evaluate the quantitative data on the relationship between receiving NTC and dietary patterns. Second, we did not obtain data on parental dietary behaviors and nutrition literacy. Parental dietary behavior and whether they received adequate nutrition education are significantly associated with dietary patterns among their children.³⁰⁻³³ However, we analyzed that adjusted for the factor parents are interested in "Shokuiku", reduced the bias of the involved parent, and reinforced the validity of the study findings. Finally, the relatively small sample size may have affected the statistical power of the analysis. Therefore, further studies with larger sample sizes are warranted.

In conclusion, the current study demonstrates that the experience of receiving NTC during elementary school is related to dietary patterns in adolescence. Enhancing NTC through the elementary school curriculum may improve literacy regarding healthy food choices among adolescents in the future. Present study may useful to educationists or policy makers formulate policy, systems for an effective nutrition program that may develop children's physical and mental growth. However, the effect of receiving NTC in elementary school on health outcomes after adolescence requires further investigation.

ACKNOWLEDGMENTS

We thank the students of the Department of Food Science and Human Wellness, Rakuno Gakuen University, for their cooperation and assistance during this study.

CONFLICT OF INTEREST

The authors no conflict of interest to disclose.

REFERENCES

1. Follong BM, Verdonschot A, Prieto-Rodriguez E, Miller A, Collins CE, Bucher T. Nutrition across the curriculum: A scoping review exploring the integration of nutrition education within primary schools. *Nutr Res Rev.* 35:181-196.2022.
2. Miyoshi M, Tsuboyama-Kasaoka N, Nishi N. School-based “Shokuiku” program in Japan: Application to nutrition education in Asian countries. *Asia Pac J Clin Nutr* 21: 159-162. 2012
3. Pittman DW, Bland IR, Cabrera ID, et al. The Boss’ healthy buddies nutrition resource is effective for elementary school students. *J Obes.* 2018: 4659874. 2018.
4. Woo T. The school meal system and school-based nutrition education in Korea. *J Nutr Sci Vitaminol.* 61:S23-S24. 2015.
5. Maldonado L, Farias SC, Damião JJ, et al. A proposal for food and nutrition education integrated into the preschool and elementary school curriculum. *Cad Saude Publica.* 37: e00152320. 2022.
6. Hawkins M, Watts E, Belson SI, et al. Design and implementation of a 5-year school-based nutrition education intervention. *J Nutr Educ Behav* 52: 421-428. 2020.
7. Moss A, Smith S, Null D, et al. Farm to school and nutrition education: Positively affecting elementary school-aged children’s nutrition knowledge and consumption behavior. *Child Obes.* 9: 51-56. 2013.
8. Jung LH, Choi JH, Bang HM, et al. A comparison of two differential methods for nutrition education in elementary school: Lecture-and experience-based learning program. *Nutr Res Pract* 9: 87-91. 2015.
9. Katz DL, Katz CS, Treu JA, et al. Teaching healthful food choices to elementary school students and their parents: The Nutrition Detectives™ program. *J Sch Health* 81: 21-28. 2011.
10. Hao M, Han W, Yamauchi T. Short-term and long-term effects of a combined intervention of rope skipping and nutrition education for overweight children in Northeast China. *Asia Pac J Public Health* 31: 348-358. 2019.
11. Ministry of Agriculture, Forestry and Fisheries. Basic act on shokuiku (food and nutrition education). 2005.
12. Asakura K, Mori S, Sasaki S, et al. A school-based nutrition education program involving children and their guardians in Japan: Facilitation of guardian-child communication and reduction of nutrition knowledge disparity. 20: 92. *Nutr J.* 2021.
13. Kuwahara M, Eum W. Effects of childhood nutrition education from school and family on eating habits of Japanese adults. *Nutrients* 14: 2517. 2022
14. Teixeira B, Afonso C, Rodrigues S, et al. Healthy and sustainable dietary patterns in children and adolescents: A systematic review. *Adv Nutr.* 13: 1144-1185. 2022.
15. Rocha NP, Milagres LC, Longo GZ, et al. Association between dietary pattern and cardiometabolic risk in children and adolescents: A systematic review. *J Pediatr.* 93(3): 214-222. 2017.
16. Bujtor M, Turner AI, Torres SJ, et al. Associations of dietary intake on biological markers of inflammation in children and adolescents: A systematic review. *Nutrients* 13: 356. 2021.
17. Peralta LR, Dudley DA, Cotton WG. Teaching healthy eating to elementary school students: A scoping review of nutrition education resources. *J Sch Health* 86: 334-345. 2016.
18. Kobayashi S, Murakami K, Sasaki S, et al. Comparison of relative validity of food group

- intakes estimated by comprehensive and brief-type self-administered diet history questionnaires against 16 d dietary records in Japanese adults. *Public Health Nutr* 14: 1200-1211. 2011.
19. Ministry of Education, Sports, Science and Technology. Standard Tables of Food Composition in Japan. 2010.
 20. Kokubun K, Yamakawa Y. Association between food patterns and gray matter volume. *Front Hum Neurosci* 13: 384. 2019.
 21. Suthuvoravut U, Takahashi K, Murayama H, et al. Association between traditional Japanese diet washoku and sarcopenia in community-dwelling older adults: Findings from the Kashiwa study. *J Nutr Health Aging* 24: 282-289. 2020.
 22. Kurotani K, Kochi T, Nanri A, et al. Dietary patterns and sleep symptoms in Japanese workers: The Furukawa Nutrition and Health Study. *Sleep Med* 16: 298-304. 2015.
 23. Textor J, van der Zander B, Gilthorpe MS, et al. Robust causal inference using directed acyclic graphs: the R package 'dagitty'. *International journal of epidemiology* 45: 1887-1894. 2016.
 24. Kobayashi T. Effects of receiving nutrition teacher's class during elementary school on dietary habits in young adulthood. *J Jpn Diet Assoc.* 61: 501-506. 2018 (in Japanese).
 25. Marshall AN, Markham C, Ranjit N, et al. Long-term impact of a school-based nutrition intervention on home nutrition environment and family fruit and vegetable intake: A two-year follow-up study. *Prev Med Rep* 20: 101247. 2020.
 26. Appannah G, Murray K, Trapp G, et al. Dietary pattern trajectories across adolescence and early adulthood and their associations with childhood and parental factors. *Am J Clin Nutr* 113: 36-46. 2021.
 27. Liberali R, Kupek E, Assis MAA. Dietary patterns and childhood obesity risk: A systematic review. *Child Obes* 16: 70-85. 2020
 28. Larson NI, Miller JM, Watts AW, et al. Adolescent snacking behaviors are associated with dietary intake and weight status. *J Nutr.* 2016;146:1348-1355.
 29. Ministry of Education, Sports, Science and Technology. Situation of assign the Diet and Nutrition Teacher. 2023.
 30. Angeles-Agdeppa I, Monville-Oro E, Gonsalves JF, et al. Integrated school based nutrition programme improved the knowledge of mother and schoolchildren. *Matern Child Nutr* 15: e12794. 2019.
 31. Davison B, Saeedi P, Black K, et al. The association between parent diet quality and child dietary patterns in nine- to eleven-year-old children from Dunedin, New Zealand. *Nutrients* 9: 483. 2017.
 32. Emmett PM, Jones LR, Northstone K. Dietary patterns in the Avon Longitudinal Study of Parents and Children. *Nutr Rev* 73(suppl 3): 207-230. 2015.
 33. Tenjin K, Sekine M, Yamada M, et al. Relationship between parental lifestyle and dietary habits of children: A cross-sectional study. *J Epidemiol* 30: 253-259. 2020.

Original**The Role of Glutamine-Arginine-HMB Supplementation in Postoperative Wound Management in Gynecologic Cancer: Case Report**

Ho Chiou Yi^{1*}, Nur Syahida Mohamad Sharif², Loh Siew Jing², Nursyafiqah Ahmad Rosfian²,
Muhammad Amirulhafidz Mat Arifin², Nur Afifah Nabila Mohd Rusmi²,
Sabena Malini A/P Vijayakumar², Norshariza Jamhuri¹,
Mohd Norazam Mohd Abas², Jamil Omar²

¹ Department of Dietetics and Food Service, Institut Kanser Negara, 4, Jalan P7, Presint 7, 62250 Wilayah Persekutuan Putrajaya, Ministry of Health, Malaysia

² Department of Gynaecology Oncology, Institut Kanser Negara, 4, Jalan P7, Presint 7, 62250 Wilayah Persekutuan Putrajaya, Ministry of Health, Malaysia

(received November 30, 2024)

ABSTRACT *Introduction:* Post-operative wound breakdown, is influenced by malnutrition, diabetes mellitus, and inadequate wound care. This case reports aimed to share our clinical practice regarding the glutamine-arginine- β -hydroxy β -methylbutyrate (HMB) incorporation in post-operative wound management. *Case presentation:* Patients A and B, who underwent laparotomy surgery, were readmitted due to surgical site infection and wound breakdown post-operative days 14-16 with wound score grade IV b. They experienced postoperative weight loss fortnightly, SGA B, and inadequate energy protein intake. Medical nutrition therapy (MNT) included a high-calorie high protein diet, lactose-free oral nutrition supplement (ONS), and orange-flavored glutamine-arginine-HMB supplementation. Daily dressing, antibiotics, and second suturing were done. Both patients were discharged with adequate oral intake and healed wounds on day 10 of admission. *Discussion:* Postoperative inadequate oral intake can significantly slow wound healing by causing nutritional deficiencies that impair protein synthesis, immune function, and overall energy availability. A post-operative multidisciplinary approach including a dietitian is indispensable to ensure optimal wound healing. An individualized MNT with ONS ensures sufficient intake of energy and protein while glutamine-arginine-HMB supplementation promotes wound healing by supporting immune function, collagen synthesis, antioxidant protection, and inflammation modulation. *Conclusion:* Adequate energy protein intake with proper dressing is crucial to assist efficient wound healing and lower complications. A multidisciplinary team approach, including individualized MNT with ONS and glutamine-arginine supplementation, is crucial for ensuring sufficient oral intake and promoting effective wound healing.

Keywords: Glutamine-Arginine-HMB, Postoperative, Wound Management

INTRODUCTION

Surgery is a primary treatment for gynecological cancer, aiming to remove cancerous tissues and potentially affected organs to achieve disease control and improve patient outcomes (1). Post-operative wound care is crucial to prevent infections, promote healing, and ensure optimal recovery (2). Surgical wound breakdown is influenced by various factors that hinder healing. Advanced age, malnutrition, obesity, and chronic illnesses like diabetes can compromise tissue integrity (3). Postoperative complications such as infection, excessive aggressive movement, and inadequate wound care can further contribute to dehiscence (3).

Optimal nutrition, providing the necessary minerals, protein, and energy needed, is essential for wound healing (3, 4). Immunonutrients like arginine and glutamine, as well as β -hydroxy β -methylbutyrate (HMB), enhance wound healing by supporting collagen synthesis, and immune function, and reducing inflammation (5). This case report aimed to share our clinical practice about glutamine-arginine-HMB incorporation in post-operative wound healing management.

CASE PRESENTATION

Patient A, 62 years old, diagnosed with endometrial carcinoma stage 3C and underlying

* To whom correspondence should be addressed:
agneshcy0326@gmail.com

partially controlled diabetes mellitus type II, underwent extra fascial hysterectomy, bilateral salpingo-oophorectomy and bilateral pelvic lymph nodes dissection. She was readmitted due to surgical site infection (SSI) and midline wound breakdown with the presence of minimal slough post-operative day 14. Based on the Southampton wound assessment (SWA) scale, her wound was grade IV b. Percentage of weight loss (4.7% fortnightly), SGA B (total score 15), inadequate oral intake (19kcal/kg/day and 0.7g/kg/day protein), and poorly controlled blood sugar (fasting blood sugar range at home 7-11mmol/L) was recorded. Medical nutrition therapy (MNT) included a strictly diabetic high protein diet, lactose-free diabetic oral nutrition supplement (ONS) (additional 675kcal/day and 30g/day protein), and 2 sachets of orange-flavored glutamine-arginine-HMB (1.55g HMB, 7.4g arginine and 7.4g glutamine per sachet) supplementation was implemented. Daily dressing and antibiotics were prescribed then proceed with secondary suturing before discharge. After day 10 of admission, the patient was discharged with adequate energy protein intake (30kcal/kg/day and 1.35g/kg/day protein) controlled blood sugar (blood sugar range 5-7mmol/L), and closed wound. Day 14 after discharged, her wound was improved (grade I c) during follow up visit in clinic.

extra fascial hysterectomy, left tumor debulking, right salpingo-oophorectomy, omentectomy, and left pelvic lymph nodes dissection. She had underlying pulmonary embolism and was on anticoagulant. Post-operative day 16, she was readmitted to the ward because there was undetected bleeding within the subcutaneous fat and SSI. Wound healing score of SWA was grade IV b. Percentage of weight loss (-3.6% fortnightly), SGA B (total score 12), and inadequate oral intake (21 kcal/kg/day and 1.0g/kg/day protein) were recorded. The blood has accumulated and formed a stabilised clot which slowly leaked out through the skin staplers. Because of the swelling and pain, the staplers were removed and the clots were evacuated to reduce pain and to avoid surgical site infection. MNT included a high calories high protein diet, lactose-free polymeric ONS (additional 660kcal/day and 26.3g/day protein), and 2 sachets of orange-flavored glutamine-arginine-HMB (1.55g HMB, 7.4g arginine and 7.4g glutamine per sachet) supplementation was implemented. Daily dressing and antibiotics were prescribed then proceed with secondary suturing before discharge. After day 10 of admission, the patient was discharged with adequate energy protein intake (33kcal/kg/day and 1.34g/kg/day protein) and a closed wound. Wound was improved (grade I a) during follow up visit in clinic day 14 after discharged.

Patient B, 36 years old, diagnosed with ovarian endometrioid carcinoma stage 3C, underwent an

Table 1 Southampton wound assessment (grade) of patients after MNT with glutamine-arginine-HMB supplement

	Day 0 (ward)	Day 5 (ward)	Day 10 (ward)	Day 24 (clinic)
Patient A	IV b	III c	II d	I c
Patient B	IV b	III b	II b	I a

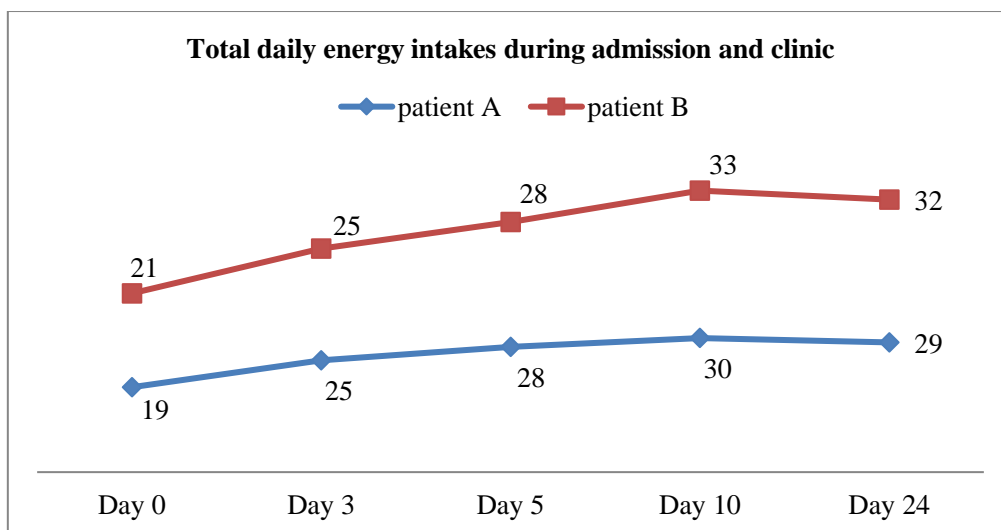


Figure 2 Total daily energy intakes during admission and clinic

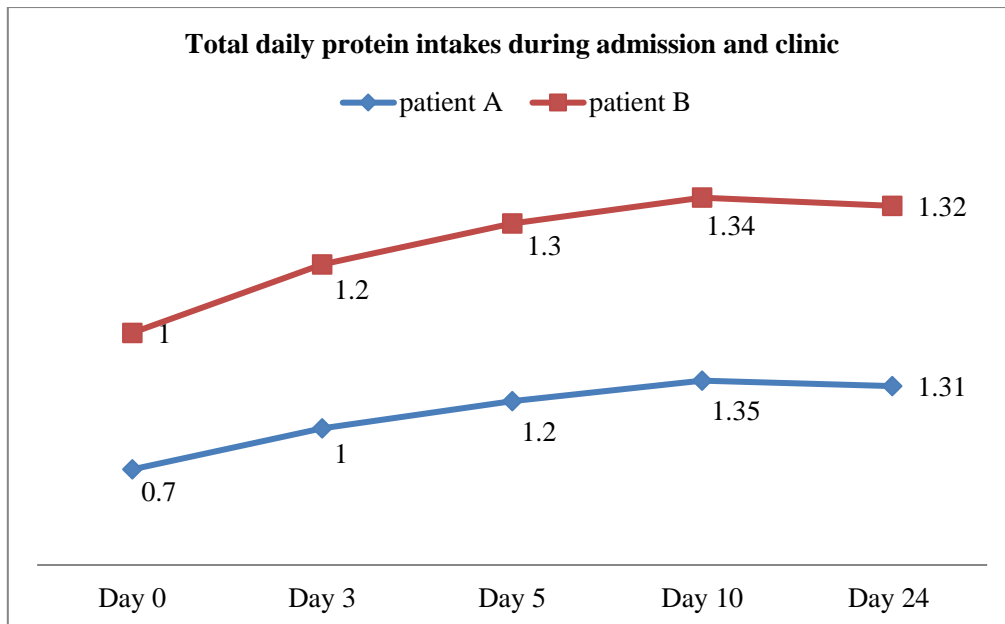


Figure 3 Total daily protein intakes during admission and clinic

DISCUSSION

Surgical wounds generally heal by primary closure during which the wound edges are brought together so that they are adjacent to each other. Wound closure is usually assisted by the use of sutures (stitches), staples, adhesive tape, or glue (6), and healing begins within hours of closure (7). Wound healing occurs in four stages, haemostasis, inflammation, proliferation and remodelling, and the appearance of the wound will change as the wound heals (8). The goal of wound management is to understand the different stages of wound healing and treat the wound accordingly (8, 9). The Southampton score was used to assess surgical wounds (10). Wounds are graded according to any complications and their extent (11). The surgical approach for SSI and wound breakdown involves assessing the wound, cleaning and debriding it, and reapproximating the wound edges using sutures, staples, or adhesive strips. Maintaining a sterile environment and providing proper postoperative care, including infection control and good nutrition, are essential for promoting healing and preventing further complications (2).

A multidisciplinary approach is indispensable in postoperative care, particularly for ensuring optimal wound healing (2, 4). Dietitians play a pivotal role in this regard, as it involves thorough assessment of nutritional requirements, regular monitoring, and the provision of personalized nutrition support tailored to each patient's needs (12). Individualized MNT with immunonutrients which are tailored to the specific needs of the patient and the type of wound are crucial for effective wound healing management (12). Nutritional support, including dietary counselling and oral nutrition supplements,

may be recommended to optimize healing outcomes and reduce complications (4). Individualized nutrition plans tailored to the patient's needs and recovery goals are essential components of post-operative care to support effective wound healing and overall recovery (12).

Optimal nutrition plays a crucial role in promoting wound healing by providing an adequate intake of minerals, protein, and energy for tissue repair and immune function (4, 13). Proteins are essential for cell regeneration and collagen formation. The production of collagen, which is necessary for wound closure and tissue repair, depends on proteins, which are the building blocks of tissues (14). Sufficient consumption of protein facilitates the wound healing process by supplying essential amino acids (15). Sustaining the higher metabolic demands linked to wound healing requires an adequate intake of energy (13). The body's ability to mend can be hampered by insufficient energy intake since it slows down tissue repair. Adequate hydration ensures proper blood flow and nutrient delivery (16). By ensuring a balanced diet rich in these nutrients, the body can effectively repair damaged tissues and reduce the risk of complications during the healing process.

Moreover, immunonutrients including glutamine, and arginine, also played an important role in wound management (17, 18). Studies showed that immunonutrients reduced postoperative wound complications (5, 17, 18). Glutamine, as a critical amino acid, provides primary energy to immunological and intestinal cells, promotes immune function by maintaining lymphocyte and macrophage activity, and aids in collagen production, which is required for wound

closure and tissue healing (19). Its antioxidant qualities shield cells from oxidative stress and boost protein synthesis, promoting tissue regeneration. Furthermore, glutamine supports intestinal barrier integrity, prevents infections, and controls inflammation to promote balanced immune responses (20). While promising, glutamine supplementation should be customized to individual patient needs, considering aspects such as health problems, nutritional state, and wound type, while adhering to clinical dosage and duration recommendations.

Arginine, an amino acid, has been shown to play a significant role in wound healing and recovery. Arginine regulates immunological responses and improves blood flow and collagen formation by acting as a precursor for nitric oxide, which promotes wound healing (21). Clinical study suggests that supplementing with arginine can enhance post-operative wound healing (17). On top of glutamine and arginine, HMB, a leucine metabolite, may aid in wound healing by increasing protein synthesis, decreasing muscle breakdown, improving immunological function, and containing anti-inflammatory effects (22). These benefits can help to enhance tissue regeneration, preserve muscle mass, prevent infections, and reduce inflammation around the wound (23).

Strengths and limitations

The current case report revealed that individualized management by dietitians is crucial to ensure adequate oral intake with ONS and glutamine-arginine-HMB supplementation to promote wound healing. This case report intends to strengthen the glutamine-arginine-HMB supplementation in MNT of wound management. The finding of the case report is hypothesis-generating. The ONS and glutamine-arginine-HMB supplement formula option was made based on routine clinical care, but this might introduce a confounding factor. More research is needed to fully understand the mechanisms and effectiveness of post-operative glutamine-arginine-HMB supplementation specifically in post-operative wound healing.

CONCLUSION

Addressing these risk factors through careful preoperative assessment, optimized surgical techniques, and diligent postoperative care is essential to prevent surgical wound breakdown. A multidisciplinary approach is crucial for postoperative management, ensuring optimal wound healing. Glutamine supplementation supports wound healing through immune function support, collagen synthesis, antioxidant protection, and modulation of inflammation, tailored to individual patient needs and clinical guidelines.

Conflict of interest

The authors declare no potential financial and non-financial conflicts of interest.

Funding source

This work did not receive any funding from public, commercial, or not-for-profit sectors.

AUTHORS' CONTRIBUTIONS

Conceptualization, methodology, formal analysis, investigation, resources, data curation, visualization, and writing original draft preparation, HCY; validation, HCY; writing – review and editing, HCY, NSMS, LSJ, NAR, MAMA, and NANMR; and supervision, NJ, MNMA, and JO. All authors read and approved the final manuscript.

ACKNOWLEDGEMENT

The authors would like to thank the nursing staff of the female surgical ward in Institut Kanser Negara, Putrajaya, Malaysia for their support in this study. The authors would like to thank the Director General of Health Malaysia for the permission to publish this paper.

REFERENCE

1. Reed N, Balega J, Barwick T, Buckley L, Burton K, Eminowicz G, et al. British Gynaecological Cancer Society (BGCS) cervical cancer guidelines: recommendations for practice. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2021;256:433-65.
2. MacKay BJ, Dardano AN, Klapper AM, Parekh SG, Soliman MQ, Valerio IL. Multidisciplinary application of an external tissue expander device to improve patient outcomes: a critical review. *Advances in Wound Care*. 2020;9(9):525-38.
3. Gould LJ, Abadir PM, White-Chu EF. Age, frailty, and impaired wound healing. *Principles and practice of geriatric surgery*. 2020:465-82.
4. Ho CY, Ibrahim Z, Abu Zaid Z, Mat Daud ZA, Mohd Yusop NB, Mohd Abas MN, et al. Postoperative Dietary Intake Achievement: A Secondary Analysis of a Randomized Controlled Trial. *Nutrients*. 2022;14(1):222.
5. Moya P, Soriano-Irigaray L, Ramirez JM, Garcea A, Blasco O, Blanco FJ, et al. Perioperative Standard Oral Nutrition Supplements Versus Immunonutrition in Patients Undergoing Colorectal Resection in an Enhanced Recovery (ERAS) Protocol: A Multicenter Randomized Clinical Trial

- (SONVI Study). *Medicine*. 2016;95(21):e3704.
6. Coulthard P, Esposito M, Worthington HV, van der Elst M, van Waes OJ, Darcey J. Tissue adhesives for closure of surgical incisions. *Cochrane Database of Systematic Reviews*. 2010(5).
 7. Rodero MP, Khosrotehrani K. Skin wound healing modulation by macrophages. *International journal of clinical and experimental pathology*. 2010;3(7):643.
 8. Gupta A, Kumar P. Assessment of the histological state of the healing wound. *Plastic and Aesthetic Research*. 2015;2:239-42.
 9. Guo S, Dipietro LA. Factors affecting wound healing. *J Dent Res*. 2010;89(3):219-29.
 10. Bailey IS, Karran SE, Toyn K, Brough P, Ranaboldo C, Karran SJ. Community surveillance of complications after hernia surgery. *British Medical Journal*. 1992;304(6825):469-71.
 11. Campwala I, Unsell K, Gupta S. A Comparative Analysis of Surgical Wound Infection Methods: Predictive Values of the CDC, ASEPSIS, and Southampton Scoring Systems in Evaluating Breast Reconstruction Surgical Site Infections. *Plast Surg (Oakv)*. 2019;27(2):93-9.
 12. Liljeberg E, Nydahl M, Lövestam E, Andersson A. A qualitative exploration of dietitians' experiences of prescribing oral nutritional supplements to patients with malnutrition: A focus on shared tailoring and behaviour change support. *Journal of Human Nutrition and Dietetics*. 2021;34(5):858-67.
 13. Weimann A, Braga M, Carli F, Higashiguchi T, Hübner M, Klek S, et al. ESPEN guideline: Clinical nutrition in surgery. *Clinical Nutrition*. 2017;36(3):623-50.
 14. Hartwell JL, Cotton A, Rozycki G. Optimizing nutrition for the surgical patient: an evidenced based update to dispel five common myths in surgical nutrition care. *The American Surgeon*. 2018;84(6):831-5.
 15. Baron JM, Glatz M, Proksch E. Optimal support of wound healing: New Insights. *Dermatology*. 2020;236(6):593-600.
 16. Giersch GE, Charkoudian N, Stearns RL, Casa DJ. Fluid balance and hydration considerations for women: review and future directions. *Sports Medicine*. 2020;50:253-61.
 17. Chapman JS, Roddy E, Westhoff G, Simons E, Brooks R, Ueda S, et al. Post-operative enteral immunonutrition for gynecologic oncology patients undergoing laparotomy decreases wound complications. *Gynecologic Oncology*. 2015;137(3):523-8.
 18. Hertlein L, Zeder-Göß C, Fürst S, Bayer D, Trillsch F, Czogalla B, et al. Peri-operative oral immunonutrition in malnourished ovarian cancer patients assessed by the nutritional risk screening. *Archives of gynecology and obstetrics*. 2018;297:1533-8.
 19. Husain MU, Azam T, Habeeb N. Evaluating the Efficacy of L-Arginine and Glutamine on Wound Healing: A literature. *Podiatric Medical Review*. 73.
 20. Barbara G, Barbaro MR, Fuschi D, Palombo M, Falangone F, Cremon C, et al. Inflammatory and microbiota-related regulation of the intestinal epithelial barrier. *Frontiers in nutrition*. 2021;8:718356.
 21. Arribas-López E, Zand N, Ojo O, Snowden MJ, Kochhar T. The effect of amino acids on wound healing: a systematic review and meta-analysis on arginine and glutamine. *Nutrients*. 2021;13(8):2498.
 22. Prado CM, Orsso CE, Pereira SL, Atherton PJ, Deutz NE. Effects of β -hydroxy β -methylbutyrate (HMB) supplementation on muscle mass, function, and other outcomes in patients with cancer: a systematic review. *Journal of cachexia, sarcopenia and muscle*. 2022;13(3):1623-41.
 23. Kerr K, Clark R, Stampas A, Nelson J, Sulo S, Pandya D. Assessing the impact of specialized oral nutrition supplementation use on wound healing. *Archives of Physical Medicine and Rehabilitation*. 2022;103(3):e36.

Original**Sensitivity of Malnutrition Screening Tool to Provide Individualized Nutrition Care for Surgical Patients by Dietitians**F.A.Z. Firouse^{1*}, A.M.N.T. Adikari², Leigh O'Brein³, Catherine L. Wall³¹ Department of Dietetics and Nutrition, Asiri Surgical Hospital, Colombo, Sri Lanka² Department of Applied Nutrition, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka³ Department of Medicine, University of Otago Christchurch, Christchurch, New Zealand

ABSTRACT *Background and Purpose:* Malnourished surgical patients face elevated risks of complications, mortality, extended hospitalization, readmissions, and increased costs. Malnutrition screening is an important initial step to enable patient-centered individualized nutrition care. The study aimed to validate the Malnutrition Screening Tool (MST) in planned surgical procedures in Sri Lanka compared with a registered dietitian malnutrition assessment to support individualized nutrition care. This cross-sectional study, conducted at a private surgical hospital in Colombo, Sri Lanka, was part of a broader initiative to enhance healthcare quality and meet international accreditation standards. *Methods:* The sample size of 100 subjects was determined based on the prevalence of malnutrition, with sensitivity and specificity considerations. All patients admitted for planned invasive surgical procedures underwent malnutrition screening by the admitting medical officer using the MST. Within 48 hours of admission, enrolled patients were assessed, independent of MST score, for malnutrition by a Registered Dietitian using the 7-point Subjective Global Assessment (7PSGA) tool. *Results:* In comparison to the 7-Point Subjective Global Assessment (7PSGA), the Malnutrition Screening Tool (MST) demonstrated a sensitivity of 78.1% and specificity of 95.6%. The positive predictive value (PPV) was 89.3%, the negative predictive value (NPV) was 90.3%, and the receiver operating characteristic (ROC) area was 0.869, suggesting good agreement between MST and 7PSGA. *Conclusion:* These results suggest that the Malnutrition Screening Tool effectively identifies malnutrition risk in patients undergoing planned invasive surgical procedures, showing a high level of agreement with the 7PSGA tool. Implementing the validated Malnutrition Screening Tool (MST) in hospitalized surgical patients will support individualized nutrition care by dietitians.

Keywords: Malnutrition, Surgical patients, Screening tools, Individualized Nutrition Care

INTRODUCTION

Individualized nutrition care is a key aspect of a patient-centered quality health care delivery system. Individualized nutrition care is tailored to a patient's specific needs, preferences, and goals. It considers key pillars including what matters to patients, shared decision-making, evidence-informed multi-modal nutritional care, and monitoring outcomes (1). Malnutrition in hospitalized patients is common(2), and often a combination of cachexia (disease-related) and malnutrition (inadequate consumption of nutrients) as opposed to malnutrition alone (3). Malnutrition in surgery wards is prevalent. A study in Vietnam (n=679) found that 51.3% of patients admitted to the surgery ward were malnourished (4). Perioperative malnutrition is an independent

predictor of poor postoperative outcomes. Malnourished patients have a higher risk of postoperative mortality, and morbidity, longer hospital stays, higher readmission rates, and elevated healthcare costs (5). Randomized trials have demonstrated that preoperative nutritional therapy reduces morbidity and surgical complications (6). Screening for malnutrition is the initial step in tailoring nutritional care, enabling early detection of individuals who are malnourished or at risk of malnutrition. This facilitates the application of the nutrition care process to those patients who are most likely to benefit.

Consequently, screening for malnutrition preoperatively is crucial to identify patients who will benefit from preoperative nutritional therapy

* To whom correspondence should be addressed:
firouseamal@gmail.com

and improve outcomes in malnourished individuals undergoing surgery (7).

A screening tool needs to be quick and simple, as they are most often administered by busy nursing staff, and must accurately identify patients at risk of malnutrition (8). There is no gold standard for nutritional screening and as such numerous nutritional screening tools are described in the literature. The most commonly used tools are the Malnutrition Universal Screening Tool, Nutritional Risk Screening 2002, and Malnutrition Screening Tool (9). Many of these tools are validated in specific populations and care contexts therefore, may not be appropriate to use in other clinical contexts. Before adopting a tool, clinicians should for which populations they were designed, and assess whether the tool aligns with the needs of their institution (10).

The Malnutrition Screening Tool (MST) is a simple, quick, valid, and reliable tool that can be used to identify patients at risk of malnutrition (11). MST has been validated for diverse patient populations, including hospitalized adults, the elderly, community-dwelling adults, cancer patients, and surgical patients [(12), (13), (14), (15)]. MST was originally validated against subjective global assessment (SGA), which is considered a gold standard for diagnosing malnutrition (16). Malnutrition screening tools need to be evaluated for reliability. Only the MST and the Malnutrition Universal Screening Tool (MUST) screening techniques have demonstrated reliability in acute and hospital-based ambulatory care settings (17). To the best of our knowledge, malnutrition screening using the MST is not routinely conducted in surgical patients preoperatively in public hospitals in Sri Lanka. To support the implementation of individualized nutrition care for surgical patients in Sri Lanka, this study aimed to assess the sensitivity of the MST in patients undergoing planned invasive surgical procedures in Sri Lanka, compared to a registered dietitian assessment of nutritional status.

MATERIALS AND METHODS

This cross-sectional study was undertaken at a private surgical hospital in Colombo, Sri Lanka. The study was conducted as part of a broader initiative to improve healthcare quality to meet international accreditation standards. Ethical approval was obtained from Wayamba University of Sri Lanka (application number 202011HI122).

From the 1st to the 7th of September 2023, all patients admitted for planned invasive surgical procedures were considered to participate in the study. Inclusion criteria were patients who underwent routine malnutrition screening using the

MST by the admitting medical officer. The Malnutrition Screening Tool (MST) screening questions were in English but for patients who may not understand English, they were translated into local Sri Lankan languages Sinhala or Tamil. Exclusion criteria comprised terminally ill patients, psychiatric patients, lactating or pregnant mothers, individuals under 18 years old, and patients or accompanying individuals who were unable to recall their previous weight or had no documented previous weight in their medical records for the last six months, or could not have their weight measured. Patients who met the inclusion and exclusion criteria and provided informed consent were enrolled in the study. Patients who provided informed consent were assessed by a Sri Lankan Registered Dietitian within 48 hours of admission using the 7-point Subjective Global Assessment (7PSGA) nutrition assessment tool to diagnose malnutrition. This assessment was completed independent of the MST score. The 7PSGA was used because it better reflects time-sensitive changes to nutrition interventions than the SGA (18). The 7PSGA component scores were summed and the following cut-off scores were used to classify the severity of malnutrition: a score of 6-7 as “well-nourished”, a score of 3-5 as “mild to moderately malnourished” and a score of 1-2 as “severely malnourished” (19).

Patient characteristics including demographics, health and medical history, and number of comorbidities, were obtained from medical records and case notes. Anthropometry measurements of weight and height were measured following the standard protocols and utilizing a “Charder” stand-on-floor scale (model MS 3450) available on the hospital ward. Body mass index (BMI) was calculated using weight and height data. The primary admission surgery type was categorized as per the NOMESCO Classification of Surgical Procedures (20). Comorbidities scores were calculated by the Charlson co-morbidity index (CCI).

The study sample size was determined using a published table derived from PASS software, considering a 50% prevalence of malnutrition, and specifying sensitivity and specificity between 0.5 to 0.8. The minimum required sample size was calculated to be 40 patients (21).

All statistical analyses were conducted using IBM SPSS software version 29.0 using data from eligible patients with complete datasets. To test the agreement between the Malnutrition Screening Tool (MST) and 7-point Subjective Global Assessment (7PSGA) tools, the scores of each tool were normalized by scaling the rating values between 0 and 1. Patients with a 7PSGA score \leq 5

were classified as “malnourished” and those with a 7PSGA score ≥ 6 as “well-nourished”. Similarly, patients with an MST score of ≤ 1 were classified as “not at risk of malnutrition” and those with a score ≥ 2 as “at risk of malnutrition”. Reliability was evaluated using kappa values and sensitivity, specificity, positive and negative predictive values (PPV/NPV), and precision was calculated. Pearson’s regression was used to compare the likelihood of detecting a change between the 7PSGA and the MST. A receiver-operating characteristic curve (ROC) curve was used to determine whether the MST score predicts malnutrition based on the 7PSGA and the area under the curve (AUROC) was calculated. Results with a $p < 0.05$ were considered statistically significant.

Table 1: Baseline Characteristics of Study Population

Characteristics	Study Population (n=100) % or mean (range) or mean (SD)
Age (years)	62.4 (18 - 87)
Gender	
Male	70
Female	30
Employment Status	
Employed	52
Unemployed	48
Charlson co-morbidity index	1.76 (2.5)
Comorbidities	
Ischemic Heart Disease	31
Diabetes Mellitus	45
Chronic Kidney Disease	4
Cancer	26
Body mass index (Asian Cut offs) (kg/m ²)	
Underweight (<18.5)	5
Normal weight (18.5-22.9)	31
Overweight (23-26.9)	36
Obese (>27)	28

RESULTS

During the study period, there were 190 admissions. Of these, 100 patients consented to participate in the research. Among the 90 patients who were excluded, 40 older adults were unable to recall their weight. Table 1 describes the baseline characteristics of the study population. In this study, the mean age of participants was 62.4 years (SD 12.7), ranging from 18 to 87 years, and the majority (70%) were male.

Additionally, 56% of the participants were over 60 years old, The mean (SD) CCI was 1.76 (2.5) and 24% of patients had another admission to the hospital within the previous two weeks. The majority of participants presented to undergo digestive tract (17%) or cardiothoracic (15%) surgeries. Table 2 summarizes the percentage of patients according to the NOMESCO surgery classification.

According to 7-point Subjective Global Assessment (7PSGA) most (68%) patients were classified as well-nourished (7PSGA score ≥ 6) and 32.0% of patients were classified as malnourished (7PSGA score ≤ 5), and the Malnutrition Screening Tool classified 28% of patients at risk of malnutrition (MST score ≥ 2) while 72 patients (72%) were classified as "not at risk of malnutrition" (MST score < 2). (Table 3).

Table 2: Percentage of patients according to NOMESCO surgery classification

Surgery Type	Study Population (n=100) (%)
Chest wall, pleura, mediastinum, diaphragm, trachea, bronchus and lung	5
Digestive system and spleen	17
Ear, nose, and larynx	1
Endocrine system	5
Enteral feeding procedures	5
Female genital organs	1
Heart and major thoracic vessels	15
Investigative procedures connected with surgery	15
Mammary gland	4
Minor surgical procedures	6
Musculoskeletal system	9
Peripheral vessels and lymphatic system	1
Procurement of organs or tissue for transplantation	1
Nervous system	1
Teeth, jaws, mouth, and pharynx	8
Urinary system, male genital organs, and retroperitoneal space	6

Table 3: Nutrition status according to 7PSGA and MST

		At Risk of Malnutrition > 2 score	Not at risk of Malnutrition <2 score	Total
		MST		
7PSGA	Severely Malnourished (1-2 ratings)	2	0	2
	Mild to Moderately Malnourished (3-5 ratings)	24	6	30
	Well Nourished (6-7 ratings)	2	66	68
	Total	28	72	100

Abbreviations: 7PSGA, 7 point subjective global assessment; MST, malnutrition screening tool

In the study, The MST accurately identified 25 of the 32 patients (78.1%) who were malnourished (true positive), and 65 of the 68 patients (95.6%) were correctly classified as well-nourished (true negative) In contrast, three patients (4.4%) of the 68 who were well nourished were classified as at risk of malnutrition (false positive) and 7 patients (21.9%) were classified as well nourished (false

negative), despite being identified as malnourished using 7PSGA. When compared with 7PSGA, MST had a sensitivity of 78.1% and specificity of 95.6% with a positive predictive value of 89.3% a negative predictive value of 90.3%, and an ROC area of 0.869, indicating good agreement (Figure 1). Kappa statistics showed $k=0.762$, $p<0.001$ indicating good agreement between the MST and 7PSGA.

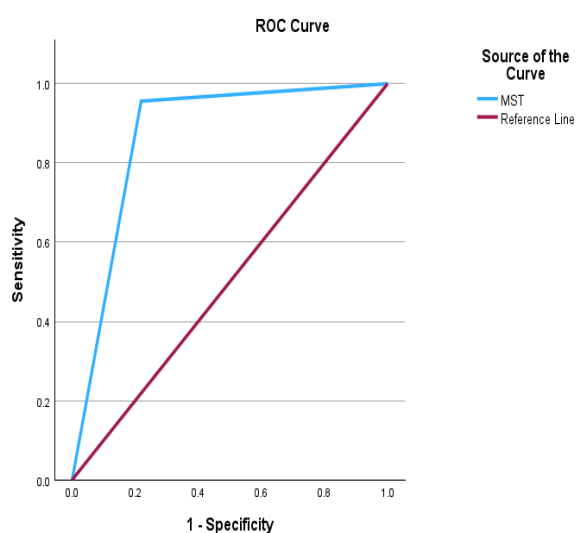


Figure 1: Receiver operator curve for identification of Malnutrition by the malnutrition screening tool.

AUROC =0.869

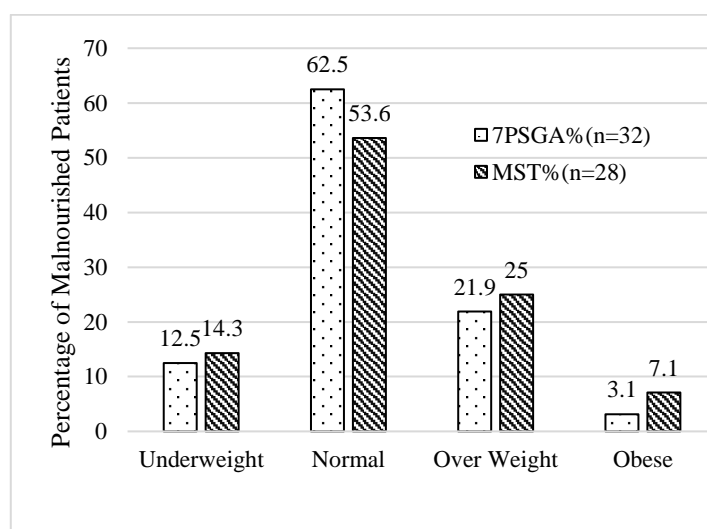


Figure 2: Percentage of Malnourished patients as per BMI category according to 7PSGA and MST

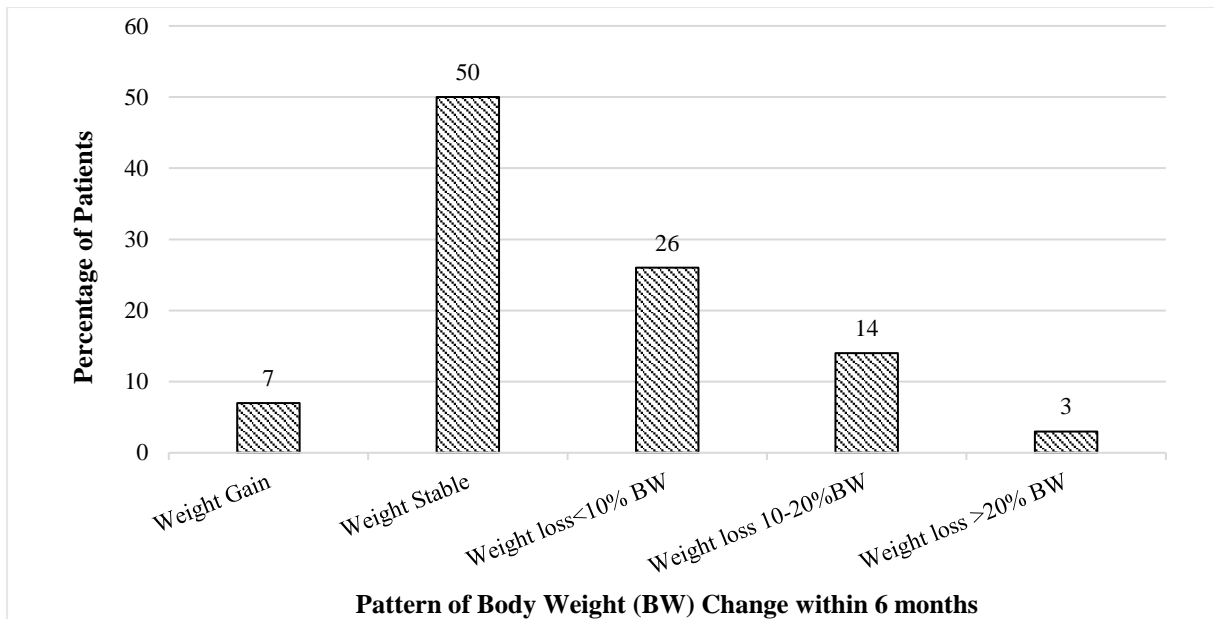


Figure 3: Reported weight change in the 6 months prior to hospital admission.

According to South Asian BMI cut-off values(22), 5% of patients were classified as underweight (BMI < 18.5 kg/m²) whereas 31% were normal weight, 36% were overweight, and 28% were classified as obese. In this population, BMI did not reliably predict whether a patient was well-nourished or malnourished before surgery. Despite only 5% of the patients being underweight in this population, screening with the Malnutrition Screening Tool(MST) indicated that 28% of all patients were at risk of malnutrition. Additionally, according to the 7-point Subjective Global Assessment (7PSGA), 32% were classified as mildly to moderately malnourished. Figure 2 illustrates the percentage of malnourished patients categorized by BMI

according to the results of MST and 7PSGA screenings.

The 7PSGA assesses unintentional weight loss in the last six months. Half (50%) of the study population did not experience any weight changes within six months. However, within the study group, 43% of patients experienced weight loss ranging from less than 10% to more than 10% of present body weight within 6 months. Three patients were found to have unintentionally lost more than 20% of weight within the same timeframe. Figure 3 depicts the pattern of weight changes within this study population.

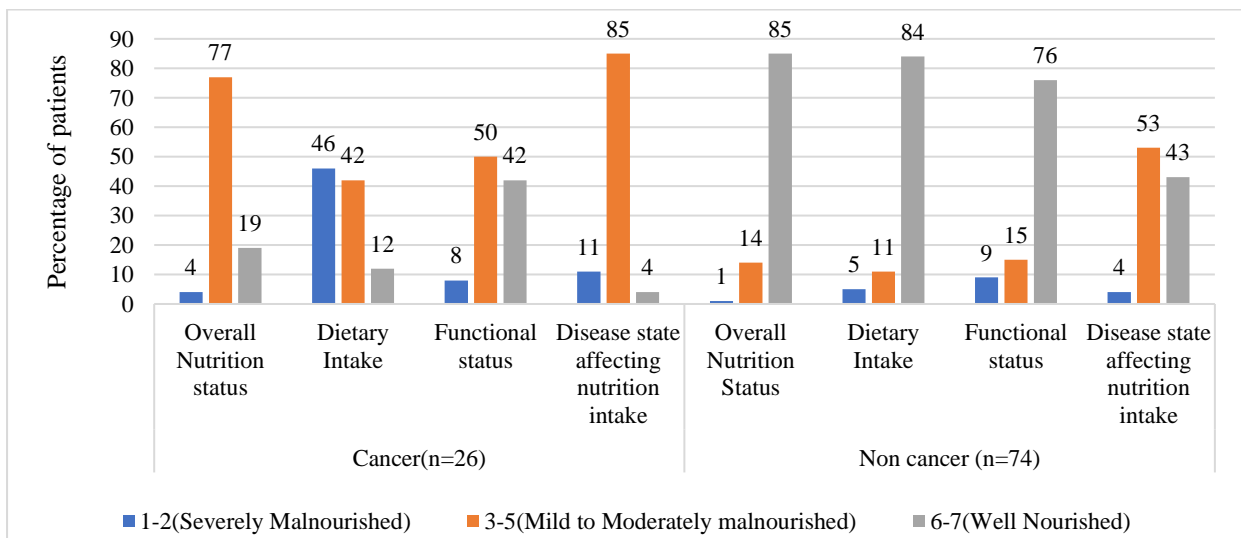


Figure 4: Nutrition Status comparison among patients with and without cancer

Malnutrition was more prevalent in patients admitted for cancer-related surgery (Figure 4). Mild to moderately malnutrition was present in 77% of patients with cancer, with 46% having poor dietary intake and disease state impacted nutrition intake for 85% of patients. Whereas Malnutrition Screening Tool (MST) identified 77% of cancer patients were at risk of malnutrition and 23% were not at risk of malnutrition. In contrast, most non-cancer patients were well-nourished and had better functional status compared to cancer patients. Also, all patients with cancer reported unintentional weight loss within the last six months (Figure 5). The median weight change for cancer patients was -7.3 kg, whereas for non-cancer patients, it was around -1.8 kg.

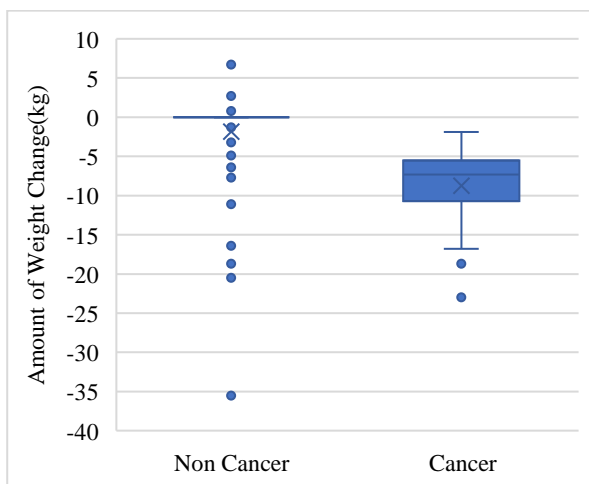


Figure 5: Body weight change in the last six months among patients with cancer (n=26) and non-cancer (n=74)

DISCUSSION

This study assessed the sensitivity of The Malnutrition Screening Tool (MST), compared to the widely used 7-point Subjective Global Assessment (7PSGA), to identify malnutrition risk among surgical patients in Sri Lanka. The MST demonstrated good agreement with the 7PSGA in identifying patients at risk of malnutrition, with a sensitivity of 78.1% and a specificity of 95.6%. This indicates that approximately 21.9% of malnourished patients identified by the 7PSGA might be missed by the MST. However, the MST accurately identifies well-nourished patients in 95.6% of cases, minimizing the risk of over diagnosing malnutrition.

Furthermore, the MST's high positive predictive value indicates that most patients identified by the MST as at risk of malnutrition truly are malnourished. Similarly, the high negative predictive value suggests that patients identified as not at risk by the MST are likely to be well-

nourished. These findings underscore the MST's practical utility in clinical settings, as it effectively balances sensitivity and specificity, reducing the likelihood of unnecessary interventions while ensuring that most at-risk patients are appropriately identified. Moreover, measures of agreement such as kappa statistics and Pearson's correlation revealed good agreement between MST and 7PSGA. Assessment of diagnostic accuracy using the area under the receiver operating characteristic curve (AUROC) showed the strongest performance between MST and 7PSGA. This study suggests that MST could be used in hospitalized surgical patients with multiple comorbidities in Sri Lanka to screen for the risk of malnutrition and subsequent referral to a registered dietitian for an individualized nutritional assessment.

Screening patients for malnutrition upon hospital admission should be considered standard practice. Nutritional status has a significant impact on surgical outcomes(23), therefore nutrition screening is a crucial initial step to assess the suitability of a patient for an operation (24). The Feed M.E. Northeast Asia Study Group recommends routine nutrition screening across various healthcare settings, including in the surgical setting, with the MST(25). The MST questionnaire has been validated in numerous countries; however, there is a lack of published data in South Asian countries. Determining whether its use effectively improves patient outcomes remains an ongoing challenge. This study was conducted in a private hospital in Sri Lanka, which may limit the generalizability of the findings to public hospital settings. Private and public healthcare environments in Sri Lanka often differ in terms of available resources, patient demographics, and healthcare delivery systems. For instance, public hospitals typically serve a broader socioeconomic population, which may include individuals with greater nutritional challenges due to limited access to healthcare and support services. These differences could impact the prevalence of malnutrition and the applicability or performance of the malnutrition screening tool in such settings. Currently, public hospitals in Sri Lanka do not routinely screen patients for malnutrition, whether they are undergoing preoperative evaluation or receiving other medical treatments. Introducing a validated malnutrition screening tool into these settings could address this gap, enabling systematic identification and management of malnutrition. Additionally, further validation of the tool in a larger population would enhance its reliability and applicability in diverse clinical settings. Future research should aim to validate this tool across diverse healthcare environments, including public hospitals, in Sri

Lanka and potentially extend nutrition screening to the broader South Asian region.

In this study, although the minimum required sample size was 40 participants, 100 patients were recruited to account for potential participant dropout or incomplete data, ensuring the study maintained sufficient statistical power. Additional participants were included to allow for subgroup analyses or exploratory investigations that were not part of the initial study plan.

In this study population of 100 patients, only 5% of patients had a BMI less than 18.5 kg/m², indicating they were underweight. In patients admitted for surgical procedures, the prevalence of underweight was lower than the prevalence of nutritional risk. Low BMI has been utilized to assess the severity of malnutrition, categorizing it as moderate or severe, according to the Global Leadership Initiative on Malnutrition (GLIM) criteria (26). In 2019, Maeda et al. established BMI cut-off values for grading malnutrition severity in Asian populations. Their findings indicated that the thresholds for moderately or severely low BMI were 17.0 kg/m² for individuals under 70 years of age and 17.8 kg/m² for those aged 70 years and older(27). The use of BMI in hospital clinical practice has several limitations. BMI is effective in diagnosing well-nourished patients; however, its use in identifying malnutrition may result in a high rate of false negatives(28). This is concerning, as it can lead to inadequate care and oversight of at-risk individuals. It does not distinguish between muscle and fat tissue, can be affected by fluid retention, and may conceal malnutrition in individuals with excess fat mass(29). Also, malnourished obese patients may experience significant weight loss without meeting the criteria for underweight classification based on BMI(30). Even among patients with a normal BMI, 62.5% were identified as malnourished according to the 7PSGA tool, while 53.6% were identified as at risk of malnutrition according to the MST tool. Furthermore, BMI fails to account for a history and pattern of body weight loss, which is a critical factor in diagnosing malnutrition(31). Interestingly, 42% of the study population experienced unintentional weight loss, but the prevalence of malnutrition, as determined by the 7-point Subjective Global Assessment (7PSGA), only 2% of patients were classified as severely malnourished, while 30% were identified as mildly to moderately malnourished. In contrast, the Malnutrition Screening Tool (MST) indicated that 28% of patients were at risk of malnutrition and required nutritional interventions. This suggests that while a significant portion of the population may have experienced weight loss, not all of them may be

classified as malnourished or at risk of malnutrition according to these assessment tools. Body weight change measurements serve as an indirect indicator of undernutrition. Body fat and skeletal muscle tend to diminish in the later stages of malnourishment meaning that body weight changes may not effectively detect marginal malnutrition or acute changes in nutritional status(32). Consequently, relying solely on basic anthropometric parameters may underestimate the nutritional risk among hospitalized patients, potentially overlooking individuals who require nutritional support(33). It is important to assess factors such as muscle mass depletion, micronutrient deficiencies, and functional status to provide a more comprehensive evaluation of nutritional health and identify potential malnutrition(34).

Conversely, significant body weight changes do indicate chronic alterations in the nutritional well-being. In this study, the median weight change of oncological patients was -7.3kg within the last 6 months

A major strength of our study was that the research dietitian, who conducted the 7-point Subjective Global Assessment (including the subjective component of 7PSGA), was blinded to the MST scores and therefore unbiased by prior knowledge. Another strength was the completion of the 7PSGA within 48 hours of admission, as per best practice guidelines (35)

A major limitation of our study is that the 40 older adults who could not recall their weight or have it measured were excluded. This was not an unexpected finding as a previous Sri Lankan study found that less than a quarter of free-living Sri Lankan adults could accurately report their body weight [36] The exclusion as these older adults may have inadvertently excluded a high-risk of malnutrition subgroup of patients that could have skewed the findings. However, the study population did include a substantial number (56 participants) of adults over 60 years old, mitigating some concerns about representation. A future Sri Lankan educational campaign, targeting both healthcare providers and patients, that focuses on highlighting the crucial role of precise weight reporting and monitoring in healthcare environments could help address this shortcoming.

To facilitate the implementation of the MST in clinical practice, practical steps should be considered. These include training healthcare staff, such as nurses and dietitians, on accurate administration and interpretation of the MST, ensuring consistency and accuracy. Additionally, integrating the MST into hospital workflows, such as incorporating it into preoperative checklists or electronic health records, would streamline the

screening process and ensure timely nutritional interventions. Establishing clear referral pathways for patients identified as at risk would further enhance the effectiveness of this tool in improving patient care in surgical settings in Sri Lanka.

In conclusion, this study demonstrated that the Malnutrition Screening Tool (MST) is a sufficiently sensitive tool, compared to a registered dietitian's assessment, for identifying patients at risk of malnutrition among those undergoing planned

invasive surgical procedures in Sri Lanka. The findings suggest that adopting the MST in surgical settings could provide a reliable means of early malnutrition risk detection, enabling healthcare providers, particularly dietitians, to implement individualized nutritional care. This, in turn, has the potential to reduce malnutrition-related surgical complications and improve overall patient outcomes.

REFERENCES

1. Holdoway, F. Page, J. Bauer, N. Dervan, and A. B. Maier, "Individualised Nutritional Care for Disease-Related Malnutrition: Improving Outcomes by Focusing on What Matters to Patients," Sep. 01, 2022, MDPI. doi: 10.3390/nu14173534.
2. S. Kabashneh, S. Alkassis, L. Shanah, and H. Ali, "A Complete Guide to Identify and Manage Malnutrition in Hospitalized Patients," *Cureus*, Jun.2020,doi:10.7759/cureus.8486.
3. E. Agarwal, "Disease-related malnutrition in the twenty-first century: From best evidence to best practice," Jul. 01, 2017, Blackwell Publishing Ltd. doi: 10.1111/1747-0080.12364.
4. P. Thi Thu Huong et al., "Prevalence of malnutrition in patients admitted to a major urban tertiary care hospital in Hanoi, Vietnam HHS Public Access Author manuscript," 2014.
5. D. G. A. Williams et al., "Tutorial: Development and Implementation of a Multidisciplinary Preoperative Nutrition Optimization Clinic," Sep. 01, 2020, John Wiley and Sons Inc. doi: 10.1002/jpen.1824.
6. F. Smedley et al., "Randomized clinical trial of the effects of preoperative and postoperative oral nutritional supplements on clinical course and cost of care," *British Journal of Surgery*, vol. 91, no. 8, pp. 983–990, Aug. 2004, doi: 10.1002/bjs.4578.
7. M. B. Cross, P. H. Yi, C. F. Thomas, J. Garcia, and C. J. Della Valle, "Evaluation of malnutrition in orthopaedic surgery," *Journal of the American Academy of Orthopaedic Surgeons*, vol. 22, no. 3, pp. 193–199, Mar. 2014, doi: 10.5435/JAAOS-22-03-193.
8. R. Cortes, M. Bannasar-Veny, E. Castro-Sanchez, S. Fresneda, J. De Pedro-Gomez, and A. Yañez, "Nutrition screening tools for risk of malnutrition among hospitalized patients: A protocol for systematic review and meta analysis," Oct. 23, 2020, Lippincott Williams and Wilkins. doi: 10.1097/MD.00000000000022601.
9. F. Neelemaat, J. Meijers, H. Kruijenga, H. Van Ballegooijen, and M. Van Bokhorst-de van der Schueren, "Comparison of five malnutrition screening tools in one hospital inpatient sample," *J Clin Nurs*, vol. 20, no. 15–16, pp. 2144–2152, Aug. 2011, doi: 10.1111/j.1365-2702.2010.03667.x.
10. M. Laporte et al., "Validity and reliability of the new Canadian Nutrition Screening Tool in the 'real-world' hospital setting," *Eur J Clin Nutr*, vol. 69, no. 5, pp. 558–564, May 2015, doi: 10.1038/ejcn.2014.270.
11. Skipper et al., "Position of the Academy of Nutrition and Dietetics: Malnutrition (Undernutrition) Screening Tools for All Adults," *J Acad Nutr Diet*, vol. 120, no. 4, pp. 709–713, Apr. 2020, doi: 10.1016/j.jand.2019.09.011.
12. Clark, E. M. Reijnierse, W. K. Lim, and A. B. Maier, "Prevalence of malnutrition comparing the GLIM criteria, ESPEN definition and MST malnutrition risk in geriatric rehabilitation patients: RESORT," *Clinical Nutrition*, vol. 39, no. 11, pp. 3504–3511, Nov. 2020, doi: 10.1016/j.clnu.2020.03.015.
13. E. A. Isenring, M. Banks, M. Ferguson, and J. D. Bauer, "Beyond Malnutrition Screening: Appropriate Methods to Guide Nutrition Care for Aged Care Residents," *J Acad Nutr Diet*, vol. 112, no. 3, pp. 376–381, Mar. 2012, doi: 10.1016/j.jada.2011.09.038.
14. E. Isenring, G. Cross, L. Daniels, E. Kellett, and B. Koczwara, "Validity of the malnutrition screening tool as an effective predictor of nutritional risk in oncology outpatients receiving chemotherapy," *Supportive Care in Cancer*, vol. 14, no. 11, pp. 1152–1156, Nov. 2006, doi: 10.1007/s00520-006-0070-5.
15. M. Ferguson, S. Capra, J. Bauer, H. Sc, M. Banks, and M. Hlth Sc, "Development of a Valid and Reliable Malnutrition Screening Tool for Adult Acute Hospital Patients," 1999.
16. Skipper et al., "Position of the Academy of Nutrition and Dietetics: Malnutrition (Undernutrition) Screening Tools for All Adults," *Kompass Nutrition & Dietetics*, vol. 1, no. 2, pp. 38–40, 2021, doi: 10.1159/000516528.

17. Skipper, M. Ferguson, K. Thompson, V. H. Castellanos, and J. Porcari, "Nutrition screening tools: An analysis of the evidence," *Journal of Parenteral and Enteral Nutrition*, vol. 36, no. 3, pp. 292–298, May 2012, doi: 10.1177/0148607111414023.
18. S. L. Lim, X. H. Lin, and L. Daniels, "Seven-Point Subjective Global Assessment Is More Time Sensitive Than Conventional Subjective Global Assessment in Detecting Nutrition Changes," *Journal of Parenteral and Enteral Nutrition*, vol. 40, no. 7, pp. 966–972, Sep. 2016, doi: 10.1177/0148607115579938.
19. M. Avesani et al., "A Comparative Analysis of Nutritional Assessment Using Global Leadership Initiative on Malnutrition Versus Subjective Global Assessment and Malnutrition Inflammation Score in Maintenance Hemodialysis Patients," *Journal of Renal Nutrition*, vol. 32, no. 4, pp. 476–482, Jul. 2022, doi: 10.1053/j.jrn.2021.06.008.
20. "NOMESCO Classification of Surgical Procedures."
21. M. A. Bujang and T. H. Adnan, "Requirements for minimum sample size for sensitivity and specificity analysis," Oct. 01, 2016, *Journal of Clinical and Diagnostic Research*. doi: 10.7860/JCDR/2016/18129.8744.
22. H. Stegenga, A. Haines, K. Jones, and J. W. Professor, "Identification, assessment, and management of overweight and obesity: Summary of updated nice guidance," *The BMJ*, vol. 349, Nov. 2014, doi: 10.1136/bmj.g6608.
23. M. A. E. de van der Schueren and H. Jager-Wittenaar, "Malnutrition risk screening: New insights in a new era," *Clinical Nutrition*, vol. 41, no. 10, pp. 2163–2168, Oct. 2022, doi: 10.1016/j.clnu.2022.08.007.
24. Z. Sun, X. J. Kong, X. Jing, R. J. Deng, and Z. Bin Tian, "Nutritional risk screening 2002 as a predictor of postoperative outcomes in patients undergoing abdominal surgery: A systematic review and meta-analysis of prospective cohort studies," Jul. 14, 2015, *Public Library of Science*. doi: 10.1371/journal.pone.0132857.
25. T. Higashiguchi et al., "Taking action against malnutrition in Asian healthcare settings: An initiative of a Northeast Asia Study Group," 2017, HEC Press. doi: 10.6133/apjcn.022016.04.
26. T. Cederholm et al., "GLIM criteria for the diagnosis of malnutrition – A consensus report from the global clinical nutrition community," *Clinical Nutrition*, vol. 38, no. 1, pp. 1–9, Feb. 2019, doi: 10.1016/j.clnu.2018.08.002.
27. K. Maeda, Y. Ishida, T. Nonogaki, and N. Mori, "Reference body mass index values and the prevalence of malnutrition according to the Global Leadership Initiative on Malnutrition criteria," *Clinical Nutrition*, vol. 39, no. 1, pp. 180–184, Jan. 2020, doi: 10.1016/j.clnu.2019.01.011.
28. V. Hainer and I. Aldhoon-Hainerová, "Obesity paradox does exist," *Diabetes Care*, vol. 36, no. SUPPL.2, Aug. 2013, doi: 10.2337/dcS13-2023.
29. J. Lima, S. Bernardes, and F. Silva, "Body mass index is not accurate to diagnose malnutrition in hospitalized patients: a cross-sectional analysis," *BRASPEN J*, vol. 37, no. 4, 2022, doi: 10.37111/braspenj.2022.37.4.09.
30. R. Barazzoni, I. Sulz, K. Schindler, S. C. Bischoff, G. Gortan Cappellari, and M. Hiesmayr, "A negative impact of recent weight loss on in-hospital mortality is not modified by overweight and obesity," *Clinical Nutrition*, vol. 39, no. 8, pp. 2510–2516, Aug. 2020, doi: 10.1016/j.clnu.2019.11.007.
31. M. Y. van Vliet, A. W. Gomes-Neto, M. F. C. de Jong, S. J. L. Bakker, H. Jager-Wittenaar, and G. J. Navis, "Malnutrition screening on hospital admission: impact of overweight and obesity on comparative performance of MUST and PG-SGA SF," *Eur J Clin Nutr*, vol. 75, no. 9, pp. 1398–1406, Sep. 2021, doi: 10.1038/s41430-020-00848-4.
32. R. A. Murphy et al., "Weight change, body composition, and risk of mobility disability and mortality in older adults: A population-based cohort study," *J Am Geriatr Soc*, vol. 62, no. 8, pp. 1476–1483, 2014, doi: 10.1111/jgs.12954.
33. Sulmont-Rossé, V. Van Wymelbeke-Delannoy, and I. Maître, "Prevalence of Undernutrition and Risk of Undernutrition in Overweight and Obese Older People," *Front Nutr*, vol. 9, May 2022, doi: 10.3389/fnut.2022.892675.
34. Eschbach et al., "Management of malnutrition in geriatric trauma patients: results of a nationwide survey," Oct. 01, 2016, *Springer Berlin Heidelberg*. doi: 10.1007/s00068-016-0698-x.
35. P. Guenter et al., "Addressing disease-related malnutrition in hospitalized patients: A call for a national goal," *Jt Comm J Qual Patient Saf*, vol. 41, no. 10, pp. 469–473, Oct. 2015, doi: 10.1016/S1553-7250(15)41061-X.
36. R. Jayawardena, N. M. Byrne, M. J. Soares, P. Katulanda, and A. P. Hills, "Body weight perception and weight loss practices among Sri Lankan adults," *Obes Res Clin Pract*, vol. 8, no. 2, 2014, doi: 10.1016/j.orcp.2013.05.003.

Original**Habitual Green Tea Consumption May Lower Systolic Blood Pressure**Shin Yamaoka^{1*}¹ Department of Food and Nutrition, Junior College Division, University of Aizu, Fukushima Japan

ABSTRACT *Background and purpose.* Green tea is believed to have beneficial effects on hypertension. However, data from intervention studies regarding the physiological effects of green tea are limited, and to clarify its effects, additional data from intervention studies are necessary to gain insights into alleviating human hypertension. Therefore, this study aimed to investigate the effects of regular green tea consumption on blood pressure in humans. *Methods.* This study included five male and female junior college students who reported no health issues. Green tea (Sencha) was purchased from a Japanese manufacturer. Green tea was distributed in teabags, and participants were asked to drink one cup of green tea daily for 2 weeks, with one teabag per cup. Blood pressure was measured at three time points: before drinking green tea (noon) and 1 and 2 weeks after starting tea consumption (noon). Blood pressure was measured twice at each time point using an upper-arm blood pressure monitor, and the average of the two measurements was recorded as the final values for systolic (SBP) and diastolic (DBP) blood pressure. *Results.* Comparison of the blood pressure measured before starting green tea consumption with that measured 1 and 2 weeks after starting green tea consumption revealed that consumption of one teabag of Sencha in a cup per day significantly decreased SBP. However, no significant difference in DBP was found when comparing the measurements taken before starting drink green tea consumption with those taken 1 and 2 weeks after. *Conclusion.* This study suggests that consuming one cup of green tea made with one teabag per day for more than 1 week may lead to a reduction in SBP.

Keywords: Green Tea, Blood Pressure, Systolic Blood Pressure

INTRODUCTION

The Guidelines for the Management of Hypertension 2019 (The Japanese Society of Hypertension) estimated that the number of patients with hypertension in Japan is approximately 43 million (1). Hypertension is considered a risk factor for the onset and progression of cardiovascular and cerebrovascular diseases (2,3). Excessive salt intake and obesity may contribute to the development of hypertension (3,4).

Green tea consumption is believed to have a beneficial effect on hypertension (5). The mechanisms by which it lowers blood pressure are thought to involve reduction of oxidative stress, improvement of endothelial function in the aorta *in vivo*, alleviation of inflammation, and improvement of endothelial function in aortic endothelial cells *in vitro*. Additionally, tea may help suppress contraction responses, improve vasodilation in the aortic tissue *in vitro*, inhibit renal sympathetic nervous system activity, and improve arterial baroreceptor function (5). However, interventional studies on the

physiological effects of green tea in humans are few, and to clarify these effects, additional data from intervention studies are needed (6). Therefore, this study aimed to investigate the effects of habitual green tea consumption on blood pressure in humans.

MATERIALS AND METHODS**Research Ethics and Participants**

This study included five male and female junior college students (aged 18 to 20 years; male n=1 and female n=4) who self-reported no health issues. This study was approved by the Ethics Committee of University of Aizu (approval number: 2024 University of Aizu No. 90). The purpose of the study was thoroughly explained to the participants, and written informed consent was obtained from all participants.

Research Design

This study used green tea from a Japanese manufacturer (Sencha; the manufacturer's name is omitted because of commercial considerations). Green tea was distributed in teabags, and

* To whom correspondence should be addressed:
aizu.yamaoka@gmail.com

participants were instructed to place one teabag in a cup of water and drink the infusion once a day for 2 weeks, at any time of the day. Blood pressure was measured twice at three time points: before starting green tea consumption during the daytime (11:50–12:20) and 1 and 2 weeks after starting green tea consumption during the daytime (11:50–12:20). Blood

pressure (systolic [SBP] and diastolic [DBP] blood pressure) was measured using an Omron Upper Arm Blood Pressure Monitor Standard 19 Series HCR-7104 (OMRON Corporation, Kyoto, Japan), and the average of the two measurements was used as the recorded value (Fig 1. Experimental Design).

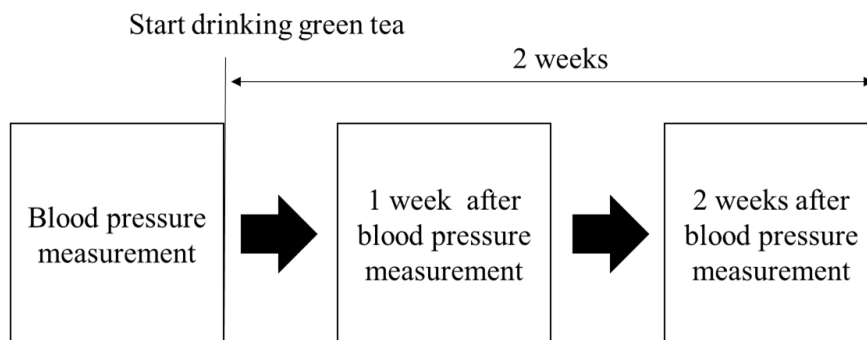


Fig 1. Experimental Design

Statistical analyses

Data are expressed as the mean \pm standard error of the mean (SEM). Statistical analyses were performed using the Student's t-test to compare the means between each group (Excel statistical software: Social Survey Research Information Co., Ltd.). Statistical significance was set at $p < 0.05$.

RESULTS

The addition of one bag of roasted green tea to a cup of water significantly decreased SBP 1 and 2 weeks after starting consumption (Fig 2). However, no significant differences were observed in DBP when comparing the measurements taken before starting green tea consumption with those taken 1 and 2 weeks later.

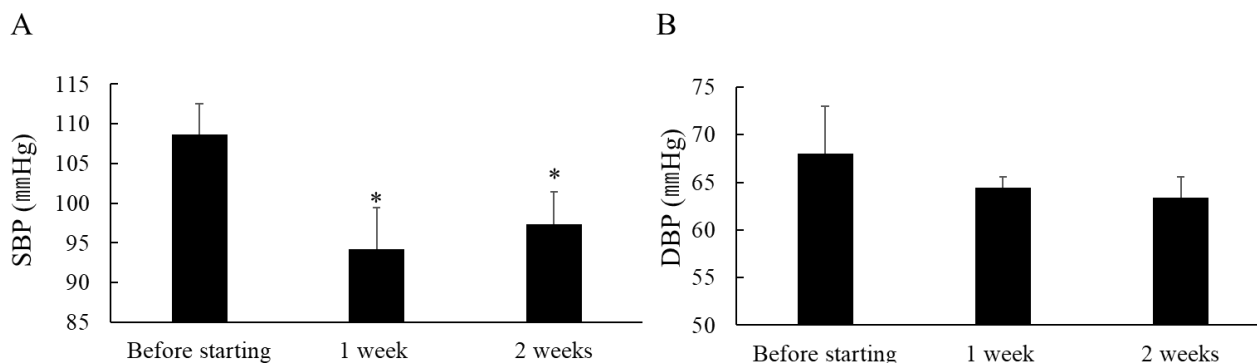


Fig 2. (A, B). Effect of green tea on SBP (A) and DBP (B). Values are presented as mean \pm SEM.

* $p < 0.05$ compared to the before starting.

DISCUSSION

The addition of one bag of roasted green tea to a cup of water significantly lowered SBP starting 1 week after consumption. However, no changes were observed in diastolic blood pressure even after drinking a cup of roasted green tea with one teabag.

To illustrate/demonstrate the reduction in blood pressure via green tea consumption, an

experiment reported that in a sodium chloride-induced hypertensive rat model, the intake of green tea extract for 6 weeks resulted in a decrease in both SBP and DBP (7). In a study conducted in China involving humans, individuals who habitually consumed green tea had significantly lower SBP than those who did not drink tea (8). Therefore, similar to the findings of previous studies, green tea consumption resulted in a

decrease in SBP, suggesting that making green tea consumption a habit may be effective in improving blood pressure (9,10).

Green tea infusion contains a large amount of polyphenols, such as catechins. Studies investigating the mechanism by which catechins lower blood pressure have revealed that they may contribute to the improvement of oxidative stress, positive regulation of angiogenesis, endothelial cell proliferation, and the signalling pathway of vascular endothelial growth factor receptors (10). In humans, the intake of epigallocatechin gallate capsules for 8 weeks in obese individuals resulted in a decrease in both SBP and DBP (11). In contrast, tea contains catechins, theanines, and amino acids (9). Administration of theanine to spontaneously hypertensive rats through drinking water resulted in a decrease in SBP (12). Therefore, the decrease in DBP after tea consumption may be attributed to the effects of the compounds present in green tea, such as catechins and theanine.

Improvements in lifestyle habits, such as regular exercise and salt intake reduction, can help improve alleviate hypertension (13,14). Therefore, a limitation of this study is that since exercise and dietary intake were not monitored during the experimental period, whether the decrease in SBP was solely due to green tea consumption remains unclear. Another limitation was that tea consumption was instructed as one teabag per cup; therefore, the exact amount of water and temperature used were unclear. As the amount of catechins in the infusion can vary depending on the green tea brewing method, each individual may consume different amounts of green tea components (15). Taken together, these factors indicate that this study only suggests a decrease in SBP from drinking one cup of green tea made with one teabag per day and does not provide definitive evidence. Future studies should clarify the tea brewing method, quantity, and lifestyle habits to better clarify the specific mechanisms by which green tea consumption leads to a reduction in blood pressure. Furthermore, this study had a small sample size of five participants, who were all young adults aged 18–20 years. Therefore, further research using a larger sample size across different age groups is warranted to investigate the impact of green tea consumption on blood pressure among a broader range of participants.

This study suggests that consuming one cup of green tea made with one teabag per day for more than 1 week leads to a reduction in SBP. Conducting more interventional studies on green tea consumption is essential to alleviate hypertension through nonpharmacological therapies.

ACKNOWLEDGMENTS

The author would like to thank the participants. The authors declare no conflicts of interest.

REFERENCES

- 1) Umemura S, Arima H, Arima S, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). *Hypertens Res* 42(9): 1235-1481. 2019.
- 2) Di Chiara T, Del Cuore A, Daidone M, et al. Pathogenetic Mechanisms of Hypertension-Brain-Induced Complications: Focus on Molecular Mediators. *Int J Mol Sci* 23(5): 2445. 2022.
- 3) He FJ, Tan M, Ma Y, et al/ Salt Reduction to Prevent Hypertension and Cardiovascular Disease: JACC State-of-the-Art Review. *J Am Coll Cardiol* 75(6): 632-647. 2020.
- 4) Landsberg L, Aronne LJ, Beilin LJ, et al. Obesity-related hypertension: pathogenesis, cardiovascular risk, and treatment: a position paper of The Obesity Society and the American Society of Hypertension. *J Clin Hypertens (Greenwich)* 15(1): 14-33. 2013.
- 5) Li D, Wang R, Huang J, et al. Effects and Mechanisms of Tea Regulating Blood Pressure: Evidences and Promises. *Nutrients* 11(5): 1115. 2019.
- 6) Tran HH, Mansoor M, Butt SRR, et al. Impact of Green Tea Consumption on the Prevalence of Cardiovascular Outcomes: A Systematic Review. *Cureus* 15(12): e49775. 2023.
- 7) Szulińska M, Stępień M, Kręgielska-Narozna M, et al. Effects of green tea supplementation on inflammation markers, antioxidant status and blood pressure in NaCl-induced hypertensive rat model. *Food Nutr Res* 61(1): 1295525. 2017.
- 8) Yin JY, Duan SY, Liu FC, et al. Blood Pressure Is Associated with Tea Consumption: A Cross-sectional Study in a Rural, Elderly Population of Jiangsu China. *J Nutr Health Aging* 21(10): 1151-1159. 2017.
- 9) Unno K, Ikka T, Yamashita H et al. Stress-Relieving Effects of Japanese Green Tea: Evaluation Using the Molar Ratio of Caffeine and Epigallocatechin Gallate to Theanine and Arginine as an Indicator. *Foods* 14(1): 103. 2025.
- 10) Tuo Y, Lu X, Tao F, et al. The Potential Mechanisms of Catechins in Tea for Anti-Hypertension: An Integration of Network Pharmacology, Molecular Docking, and Molecular Dynamics Simulation. *Foods* 13(17): 2685. 2024.
- 11) Chatree S, Sitticharoon C, Maikaew P, et al. Epigallocatechin gallate decreases plasma triglyceride, blood pressure, and serum kisspeptin in obese human subjects. *Exp Biol Med*

(Maywood) 246(2): 163-176. 2021.

12) Matsuoka K, Akaihata H, Hata J, et al. L-Theanine Protects Bladder Function by Suppressing Chronic Sympathetic Hyperactivity in Spontaneously Hypertensive Rat. *Metabolites* 11(11):778. 2021.

13) Murase S, Sakitani N, Maekawa T, et al. Interstitial-fluid shear stresses induced by vertically oscillating head motion lower blood pressure in hypertensive rats and humans. *Nat Biomed Eng* 7(11): 1350-1373. 2023.

14) Whelton PK, Appel LJ, Espeland MA, et al. Sodium reduction and weight loss in the treatment of hypertension in older persons: a randomized controlled trial of nonpharmacologic interventions in the elderly (TONE). TONE Collaborative Research Group. *JAMA* 279(11): 839-46. 1998.

15) Orita T, Chogahara S, Okuda M, et al. Extraction Efficiency and Alpha-Glucosidase Inhibitory Activities of Green Tea Catechins by Different Infusion Methods. *Foods* 12(13): 2611. 2023.

Original**Association of Habitual Coffee Consumption with Probable Sarcopenia Assessed Using SARC-F in Community-Dwelling Japanese Older Adults: A Cross-Sectional Study**Akinori Yaegashi^{1,2*}, Otoha Kohata², Tohru Kobayashi³, Nobuya Kimura³, Mikako Sakaya³, Rumi Ohta⁴, Haruka Yokoyama⁴¹*Department of Nutrition, Faculty of Health and Welfare, Takasaki University of Health and Welfare, Takasaki, Gunma 370-0033, Japan*²*Department of Health and Nutrition, Faculty of Human Science, Hokkaido Bunkyo University, 5-196-1, Kogane-chuo, Eniwa 061-1449, Japan*³*Department of Food Science and Human Wellness, Rakuno Gakuen University, 582 Bunkyo-dai-Midorimachi, Ebetsu, 069-8501, Japan*⁴*Department of Health and Welfare Service, Government of Mukawa City, 2-88, Miyuki, Mukawa 05-0042, Japan*

ABSTRACT *Background and purpose.* To date, no study has examined the effect of coffee on sarcopenia while accounting for the intake of antioxidant-containing vegetables and fruits. We aimed to ascertain the association between habitual coffee consumption and probable sarcopenia among older Japanese adults using a screening tool for sarcopenia (strength, assistance with walking, rising from a chair, climbing stairs, and falls). *Methods.* This cross-sectional study was conducted in Mukawa, Hokkaido, Japan, between June and September 2022 and included 364 Japanese participants aged ≥ 65 years. Habitual coffee consumption was assessed using a validated self-administered food frequency questionnaire. Probable sarcopenia was determined using the “strength, assistance with walking, rising from a chair, climbing stairs, and falls” (SARC-F) scale. Multivariate logistic regression analysis was conducted to estimate the odds ratios (ORs) and confidence intervals (CIs) of probable sarcopenia risk across coffee consumption tertiles, with adjustments for sex, age, body mass index, living alone, habitual exercise, walking hours, current smoking status, current alcohol consumption, energy intake, and protein, fruit, and vegetable intake. *Results.* In our sample of 364 participants (154 males and 210 females), the probable sarcopenia rate was 9.3%. The multivariate-adjusted OR (95% CI) of ≥ 2 cups/day of coffee consumption compared with ≤ 3 cups/week for probable sarcopenia was 0.20 (0.06, 0.63) (p for trend=0.005). Increased habitual coffee consumption was inversely associated with probable sarcopenia in older Japanese adults. *Conclusions.* Coffee consumption of ≥ 2 cups/day may prevent sarcopenia. Further longitudinal studies are required to confirm these findings.

Keywords: coffee, cross-sectional study, nutritional epidemiology, older adult, sarcopenia

INTRODUCTION

Sarcopenia is a skeletal muscle disorder involving accelerated loss of muscle mass and function (1). Its prevalence rate ranges from 10% to 27% for the population aged ≥ 60 years (2). The number of people aged ≥ 65 years is expected to double from 703 million in 2019 to 1.5 billion in 2050, and the proportion is projected to increase from 9% to

16% (3). Sarcopenia is associated with increased poor health outcomes, including falls, functional decline, frailty, and mortality (1). Therefore, it is important to identify lifestyle factors that can reduce the risk of sarcopenia.

Sarcopenia is caused by various factors, including oxidative stress and inflammation (1,4); therefore, anti-inflammatory and antioxidant agents are considered to

* To whom correspondence should be addressed:
journal.y2024@gmail.com

reduce sarcopenia. Coffee, which is the most frequently consumed beverage, contains phenolic compounds, such as chlorogenic acid and caffeic acid, which have strong antioxidant and anti-inflammatory effects as well as the potential to induce autophagy (5-8). Therefore, coffee consumption may prevent sarcopenia caused by inflammation and oxidative stress.

Four cross-sectional studies in humans have reported an association between coffee consumption and skeletal muscle mass, a key component of sarcopenia (9-12). Three studies showed that a significant positive association was found between higher coffee consumption and skeletal muscle mass loss (9-11). However, one study reported that light coffee consumption is protective against skeletal muscle mass loss. Specifically, the association between skeletal muscle mass and men who drink 1 cup of coffee per day remained significant, whereas no significant relationship was observed in men who drink ≥ 3 cups of coffee daily). A possible reason for the inconsistent results is that these studies (9-12) did not adjust for antioxidant-rich vegetables and fruits. Antioxidant-containing vegetables and fruits have been associated with a low risk of sarcopenia (13,14); thus, the influence of vegetables and fruits should be excluded when examining the association between coffee and skeletal muscle mass loss.

Therefore, the current study examined the association between habitual coffee consumption and probable sarcopenia among older Japanese adults, while accounting for vegetable and fruit intake.

MATERIALS AND METHODS

Study design and population

This cross-sectional study was conducted in Mukawa, east of Sapporo City, Hokkaido, Japan, between June and September 2022. The survey targeted individuals aged ≥ 20 years living in Mukawa. The town has a land area of 711.36 km² and a population of 7,579 individuals, with 41.2% of the population aged ≥ 65 years. In total, 1,051 residents were sent a postal invitation that included the study questionnaires. The completed questionnaires and written informed consent forms were collected by post. Residents underwent specific health checkups, medical checkups for older adults, and cancer screening. In total, 551 individuals were included in the study; based on the results of the checkups and screening, 500 were included via stratified random sampling, and 100 individuals were randomly selected from each age group from the basic resident register maintained until April 30, 2022. Age distribution in our sample was as follows: 20–29 years (n=100), 30–39 years (n=100), 40–49 years (n=146), 50–59 years (n=144), 60–69 years (n=220), 70–79 years (n=225), 80–89 years (n=108), and 90–99 years (n=8).

All participant information was anonymized and de-identified before the analysis. The study protocol, which complied with the tenets of the Declaration of Helsinki, was approved by the Ethics Committee of Rakuno Gakuen University (No. 22-1).

Dietary assessment

The validated self-administered Brief Diet History Questionnaire (BDHQ) (15-17) was used to evaluate the diet of the participants in the preceding month. The frequency of coffee consumption was classified into the following categories: almost none, < 1 cup/month, 1 cup/week, 2–3 cups/week, 4–6 cups/week, 1 cup/day, 2–3 cups/day, or 4 cups/day.

A previous study assessed the validity of the BDHQ using dietary records. The correlation coefficients according to the BDHQ and those obtained from 16-day dietary records were 0.85 (males) and 0.87 (females) for coffee consumption, respectively, in a sample of 92 male participants aged 32–76 years and 92 female participants aged 31–69 years (16). In another sample of 36 male participants and 44 female participants aged 82–94 years, the correlation between a 3-day non-consecutive dietary record and the BDHQ was 0.67 for coffee consumption (17). Food and beverage data from the Standard Tables of Food Composition in Japan were used to calculate energy and protein intake. The types of coffee (type of beans or boiled/filtered/instant coffee) were not evaluated.

Probable sarcopenia assessment

Probable sarcopenia was assessed using the “strength, assistance with walking, rising from a chair, climbing stairs, and falls” (SARC-F) scale (17,18), which was initially developed in English and then translated into Japanese (19). The SARC-F includes questions in five domains: (1) strength, (2) walking assistance, (3) rising from a chair, (4) climbing stairs, and (5) falling. Each domain has single items, with scores ranging from 0 to 2 (Supplementary Table 1), and the total score ranged from 0 (best) to 10 (worst). A total score of 4 or higher indicates probable sarcopenia, and this study defined a score of 4 or higher as indicative of probable sarcopenia (18,19). In one study involving 959 hospitalized Japanese patients, the SARC-F showed a sensitivity of 41.7% and specificity of 68.5% (19).

Other variable assessments

Patient data, namely age, height, body weight, and alcohol consumption status, were collected through self-reported responses to the BDHQ questionnaire. The body mass index (BMI) was calculated as weight (in kg) divided by height squared (in m²). Participants were classified into three BMI categories based on the 2022 guidelines for obesity management in Japan (20): < 18.5 , 18.5–24.9, and ≥ 25 kg/m². Alcohol consumption status was classified into eight categories ranging from almost none to daily. The participants also provided information on their living status (alone or with a companion), household income (four categories ranging from < 2 to ≥ 6 million JPY), habitual exercise (defined as exercise for ≥ 30 min at least twice a week, for 1 year or more), walking hours (four categories ranging from < 0.5 to ≥ 2 h/day), and smoking status (four categories: daily, sometimes, formerly, and never).

Statistical analyses

Participants' coffee consumption was divided into three categories: ≤ 3 cups/week, 4 cups/week–1 cup/day, and ≥ 2 cups/day. The data for both male and female participants were analyzed because the number of male participants was low. Participant characteristics were compared based on coffee consumption categories using linear regression analyses for continuous variables and the Mantel–Haenszel test for categorical variables.

The adjusted odds ratios (ORs) and confidence intervals (CIs) for probable sarcopenia were estimated according to coffee consumption using logistic regression analysis with the lowest category (< 2 cups/week) as the reference. Model 1 was adjusted for sex (male or female), age (years, continuous), BMI (< 18.5 , 18.5 – 24.9 , or ≥ 25 kg/m², or missing data), living alone (yes or no), habitual exercise (yes or no), walking hours (< 0.5 , 0.5 – 0.9 , 1.0 – 1.9 , or 2 h/d), current smoking status (yes or no), current alcohol consumption (< 1 cup/week or ≥ 1 cup/week), energy intake (kcal, continuous), and protein intake (g, continuous). Model 2 was adjusted for fruit and vegetable intake (g, continuous) because they have antioxidant properties that may modulate the effect of coffee consumption on probable sarcopenia. All statistical analyses were performed using SAS (ver. 9.4 Windows SAS Institute, Cary, NC, USA). Statistical significance was set at $p < 0.05$.

RESULTS

A total of 623 participants (450 from specific health checkups, medical checkups for older adults, and cancer screening [40–49 years { $n=33$ }; 50–59 years { $n=39$ }; 60–69 years { $n=98$ }; 70–79 years { $n=191$ }; 80–89 years { $n=86$ };

and 90–99 years { $n=8$ }] and 173 from stratified random sampling [20–29 years { $n=35$ }; 30–39 years { $n=33$ }; 40–49 years { $n=31$ }; 50–59 years { $n=33$ }; and 60–69 years { $n=41$ }] completed the questionnaire survey (response rate, 79.6%; [specific health checkups, medical checkups for older adults, or cancer screening, 81.7%; and stratified random sampling, 34.6%]). Among them, 365 participants (aged ≥ 65 years) were eligible for inclusion. We excluded one participant with missing data in the SARC-F questionnaire ($n=1$). Thus, 364 participants were included in this study. An overview of the study enrolment procedure is shown in Figure 1. The proportion of women in the sample was 57.7%. The mean (standard deviation) age was 74.6 (6.1) (range, 65–94) years. Probable sarcopenia (sarcopenia score ≥ 4) was 9.3%.

Table 1 presents the participant characteristics according to coffee consumption. Participants with higher coffee consumption tended to have higher total energy, protein, vegetable, and fruit intakes.

Table 2 shows the crude and multivariate-adjusted ORs and 95% CIs for probable sarcopenia based on coffee consumption. The ORs of probable sarcopenia were significantly lower in the group with the highest coffee consumption (≥ 2 cups/day) than in the group with the lowest consumption (≤ 3 cups/week) after adjusting for sex, age, BMI, living alone, habitual exercise, walking hours, current smoking status, current alcohol consumption, energy intake, and protein intake (OR [95% CI]=0.20 [0.06, 0.64], p for trend=0.004) (Model 1 in Table 2). Similar results were obtained after adjusting for fruit and vegetable intake (OR [95% CI]=0.20 [0.06, 0.63]; p for trend=0.005) (Model 2 in Table 2).

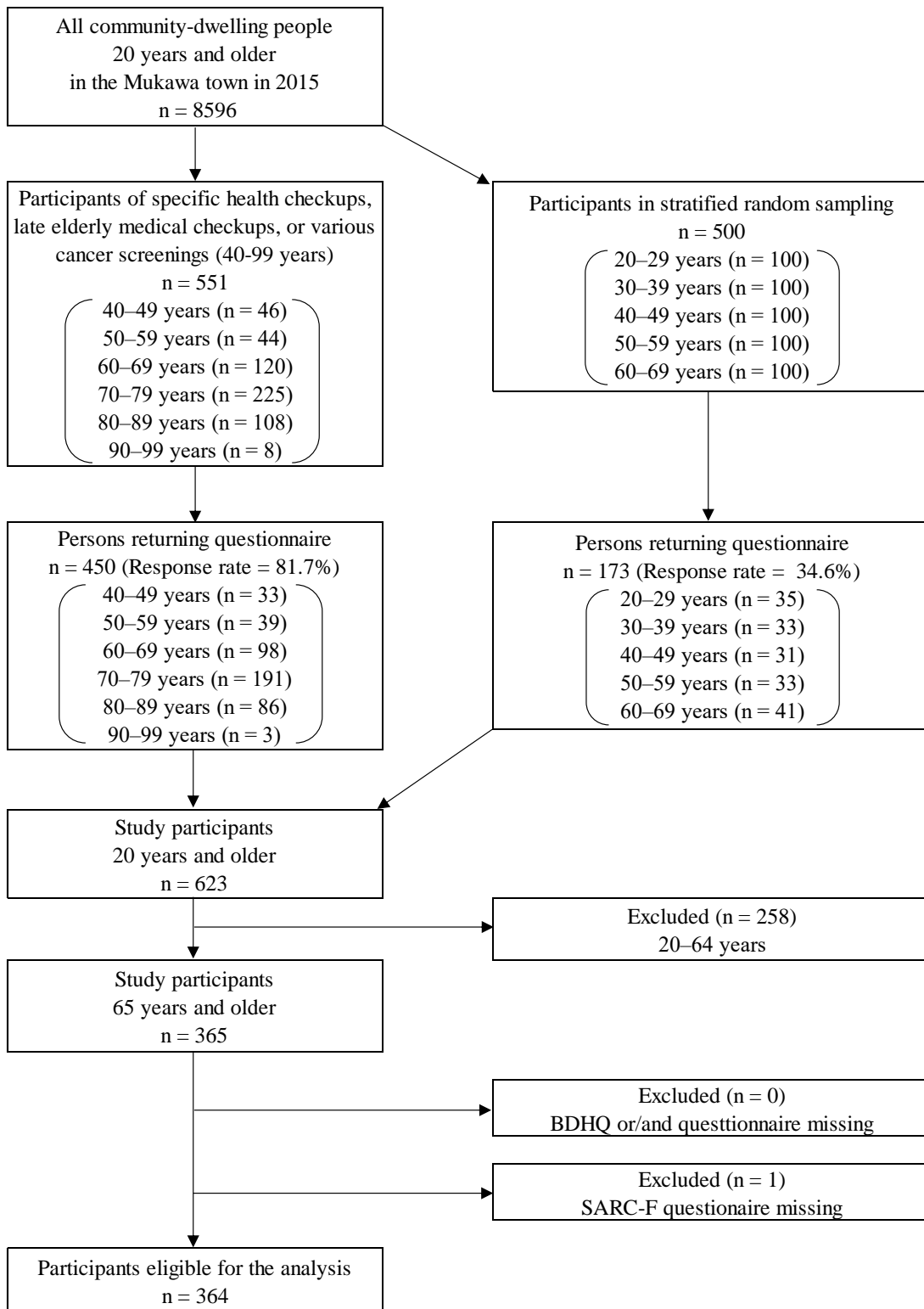


Figure 1. Flowchart depicting the participant enrolment process for this study

BDHQ, Brief Diet History Questionnaire; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls

Table 1. Participant characteristics stratified by coffee consumption categories

	Coffee consumption						<i>p</i> for trend [†]
	≤3 cups/week		4 cups/week–1 cup/day		≥2 cups/day		
	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	
All (n = 364)	(n=119)		(n=126)		(n=119)		
Age (years) [†]	76.5	6.5	73.6	6.2	73.7	5.1	<0.001
Females, n (%)	68	57.1	67	53.2	75	63.0	0.294
BMI, kg/m ² [†]	23.9	4.2	23.1	3.7	23.6	3.7	0.624
BMI, kg/m ² , n (%) [§]							
<18.5	9	7.6	13	10.3	5	4.2	0.356
18.5–25	65	54.6	75	59.5	72	60.5	
≥25	44	37.0	38	30.2	42	35.3	
Missing							
Energy intake (kcal) [†]	1716	613	1682	540	1793	547	0.298
Protein (g) [†]	70.9	31.1	67.9	25.9	77.2	28.1	0.085
Vegetable (g) [†]	254.0	145.2	251.9	147.2	300.5	163.6	0.019
Fruit (g) [†]	94.5	82.9	98.6	92.1	104.0	82.4	0.393
Green tea consumption [§]							0.643
<1 cup/week	33	27.7	36	28.6	26	21.9	
1–6 cup/week	24	20.2	34	27.0	32	26.9	
≥1 cup/day	62	52.1	56	44.4	61	51.3	
Living alone, n (%) [§]	27	22.7	27	21.4	21	17.7	0.606
Household income (<4 million JPY), n (%) [§]	94	79.0	99	78.6	94	79.0	
Missing	18	15.1	12	9.5	14	11.8	0.3572
Habitual exercise, n (%) ^{§¶}	69	58.0	74	58.7	60	50.4	0.357
Walking hours, h/day, n (%) [§]							0.548
<0.5	21	17.7	18	14.3	18	15.1	
0.5–0.9	43	36.1	37	29.4	36	30.3	
1–1.9	25	21.0	37	29.4	26	21.9	
≥2	30	25.2	34	27.0	39	32.8	
Educational level, n (%) [§]							0.153
Junior and senior high school graduates	105	88.2	108	85.7	94	79.0	
Junior college/vocational school graduate	7	5.9	13	10.3	13	10.9	
Universities/postgraduate schools	6	5.0	5	4.0	12	10.1	
Missing	1	0.8	0	0.0	0	0.0	
Current smoker, n (%) [§]	4	3.4	18	14.3	11	9.2	0.012
Current alcohol consumption (≥1 cup/week), n (%) [§]	34	28.6	52	41.3	46	38.7	0.107
Missing data	1	0.8	0	0.0	0	0.0	
Probable sarcopenia, n (%) [§]	19	16.0	11	8.7	4	3.4	0.004

Bold *p*-values are statistically significant (*p*<0.05).. BMI, body mass index; SD, standard deviation. Values are expressed as means (SDs) for continuous variables and numbers (percentages) for categorical variables. *p*-values for linear trends across quartiles (assigned ordinal numbers 0–2) of coffee consumption are based on linear regression analysis for continuous variables and the Mantel test for categorical variables. [†]Continuous values are shown as means and standard deviations.

[§]Categorical values are shown as numbers and percentages. Habitual exercise was defined as ≥30 min/session and ≥2 times/week for at least 1 year. Probable sarcopenia was defined as scores ≥4 using SARC-F

Table 2. Crude and multivariate-adjusted odds ratios and 95% confidence intervals of probable sarcopenia according to coffee consumption

	Coffee consumption			<i>p</i> for trend [†]
	≤3 cups/week	4 cups/week-1 cup/day	≥2 cups/day	
All, n	119	126	119	
Probable sarcopenia, n (%)	19 (16.0)	11 (8.7)	4 (3.4)	
Crude model	1.00 (reference)	0.50 (0.23, 1.11)	0.18 (0.06, 0.56)	0.001
Model 1 [‡]	1.00 (reference)	0.64 (0.27, 1.49)	0.20 (0.06, 0.64)	0.006
Model 2 [§]	1.00 (reference)	0.63 (0.27, 1.47)	0.20 (0.06, 0.63)	0.005

Bold *p*-values are statistically significant (*p*<0.05).

[†]Based on the multiple logistic regression analysis with ordinal numbers 0–2 assigned to quartile-based categories of consumption.

[‡]Adjusted for sex (male or female), age (years, continuous), BMI (<18.5, 18.5–24.9, or ≥25 kg/m², or missing data), living alone (yes or no), habitual exercise (yes or no), walking hours (<0.5, 0.5–0.9, 1.0–1.9, or 2 h/day), current smoking status (yes or no), current drinking (<1 cup/week or ≥1 cup/week), energy intake (kcal, continuous), and protein intake (g, continuous).

[§]Model 1+ fruit and vegetable intake (g, continuous).

DISCUSSION

This study demonstrated a negative correlation between coffee consumption and probable sarcopenia using the SARC-F scale in older Japanese adults. This association remained unchanged after adjusting for antioxidant-containing fruits and vegetables.

The results of the present study may be explained by phenolic compounds such as chlorogenic acid and caffeic acid, which are abundant in coffee. Chronic inflammation has been identified as a major factor that exacerbates the pathogenesis of sarcopenia (21). Aging is characterized by a redox imbalance between increased reactive oxygen species production and reduced antioxidant defense (22). In general, aging increases reactive oxygen species production in skeletal muscle (22). Thus, we considered that phenolic compounds such as chlorogenic acid and caffeic acid, which are abundant in coffee, exert anti-inflammatory and antioxidant effects and prevent sarcopenia caused by oxidative stress.

Several cross-sectional studies have reported an association between coffee consumption and skeletal muscle mass loss, a component of sarcopenia (9-12). However, these previous studies (9-12) did not adjust for antioxidant-containing fruit

and vegetable intake. Hence, to the best of our knowledge, this is the first study to account for the antioxidants in fruits and vegetables, allowing us to analyze the effect of coffee on sarcopenia without this confounder factor.

The results of our study may aid in the development of preventative measures against sarcopenia and facilitate further research on methods of preventing sarcopenia. However, this study had a few limitations. First, because this study used a cross-sectional design, we could not determine whether the association between coffee consumption and probable sarcopenia was causal. Second, because the coffee consumption assessment was self-administered, the problem of potential misclassification arose. Third, the possibility of residual confounding factors could not be ruled out. For example, the consumption of foods other than coffee or tea and the intake of nutrients may have affected the results, although we adjusted for protein. Fourth, our sample size was small. Therefore, further large-scale studies are warranted. Fifth, we were unable to diagnose true sarcopenia because we used the SARC-F scale. However, we believe that the SARC-F scale accurately determined sarcopenia because, in a validation study, the SARC-F scale showed a sensitivity of 41.7% and a specificity of 68.5%¹⁸ and the prevalence of probable sarcopenia in this study was

similar to that observed in the previous Japanese meta-analyses (prevalence of sarcopenia: 9.3% in our study; 9.9% in previous meta-analyses in Japan) (23). Sixth, we did not examine individual coffee types (type of beans or boiled/filtered/instant coffee). The amount of chlorogenic acid in coffee is known to vary by type (24,25). Therefore, the ranking of coffee consumption may not be consistent with the levels of chlorogenic acid and polyphenols, which are the factors that exert anti-inflammatory and antioxidative effects.

In conclusion, coffee consumption was inversely associated with probable sarcopenia. This association remained unchanged after adjusting for the intake of antioxidant-containing vegetables and fruits. Coffee consumption of ≥ 2 cups/day may prevent sarcopenia. Further longitudinal studies are required to confirm these findings.

ACKNOWLEDGMENTS

We would like to express our gratitude to all the participants. We would like to thank Editage (www.editage.com) for the English language editing.

DATA AVAILABILITY STATEMENT

The data analyzed in this study are not publicly available because of privacy and ethical restrictions.

REFERENCES

1. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, Cooper C, Landi F, Rolland Y, Sayer AA, Schneider SM, Sieber CC, Topinkova E, Vandewoude M, Visser M, Zamboni M; Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing* 48: 16–31. 2019.
2. Petermann-Rocha F, Balntzi V, Gray SR, Lara J, Ho FK, Pell JP, Celis-Morales C. Global prevalence of sarcopenia and severe sarcopenia: a systematic review and meta-analysis. *J Cachexia Sarcopenia Muscle* 13: 86–99. 2022.
3. United Nations. World Population Ageing 2019. 2019. <https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Report.pdf>. Accessed DD MM YYYY.
4. Cruz-Jentoft AJ, Sayer AA. Sarcopenia. *Lancet* 393: 2636–2646. 2019.
5. Clifford MN. Chlorogenic acids and other cinnamates – nature, occurrence, dietary burden, absorption and metabolism. *J Sci Food Agric* 80: 1033–1043. 2000.
6. Andersen LF, Jacobs DR Jr, Carlsen MH, Blomhoff R. Consumption of coffee is associated with reduced risk of death attributed to inflammatory and cardiovascular diseases in the Iowa Women’s Health Study. *Am J Clin Nutr* 83: 1039–1046. 2006.
7. Lopez-Garcia E, van Dam RM, Qi L, Hu FB. Coffee consumption and markers of inflammation and endothelial dysfunction in healthy and diabetic women. *Am J Clin Nutr* 84: 888–893. 2006.
8. Pietrocola F, Malik SA, Mariño G, Vacchelli E, Senovilla L, Chaba K, Niso-Santano M, Maiuri MC, Madeo F, Kroemer G. Coffee induces autophagy in vivo. *Cell Cycle* 13: 1987–1994. 2014.
9. Kawakami R, Tanisawa K, Ito T, Usui C, Ishii K, Muraoka I, Suzuki K, Sakamoto S, Higuchi M, Oka K. Coffee consumption and skeletal muscle mass: WASEDA’s Health Study. *Br J Nutr* 130: 127–136. 2023.
10. Iwasaka C, Yamada Y, Nishida Y, Hara M, Yasukata J, Miyoshi N, Shimano C, Nanri H, Furukawa T, Koga K, Horita M, Higaki Y, Tanaka K. Association between habitual coffee consumption and skeletal muscle mass in middle-aged and older Japanese people. *Geriatr Gerontol Int* 21: 950–958. 2021.
11. Chung H, Moon JH, Kim JI, Kong MH, Huh JS, Kim HJ. Association of coffee consumption with sarcopenia in Korean elderly men: Analysis using the Korea National Health and Nutrition Examination Survey, 2008–2011. *Korean J Fam Med* 38: 141–147. 2017.
12. Kim JH, Park YS. Light coffee consumption is protective against sarcopenia, but frequent coffee consumption is associated with obesity in Korean adults. *Nutr Res* 41: 97–102. 2017.
13. Liguori I, Russo G, Curcio F, Bulli G, Aran L, Della-Morte D, Gargiulo G, Testa G, Cacciatore F, Bonaduce D, Abete P. Oxidative stress, aging, and diseases. *Clin Interv Aging* 13: 757–772. 2018.
14. Koyanagi A, Veronese N, Solmi M, Oh H, Shin JI, Jacob L, Yang L, Haro JM, Smith L.

- Fruit and vegetable consumption and sarcopenia among older adults in low- and middle-income countries. *Nutrients* 12: 706. 2020.
15. Kobayashi S, Honda S, Murakami K, Sasaki S, Okubo H, Hirota N, Notsu A, Fukui M, Date C. Both comprehensive and brief self-administered diet history questionnaires satisfactorily rank nutrient intakes in Japanese adults. *J Epidemiol* 22: 151–159. 2012.
 16. Kobayashi S, Murakami K, Sasaki S, Okubo H, Hirota N, Notsu A, Fukui M, Date C. Comparison of relative validity of food group intakes estimated by comprehensive and brief-type self-administered diet history questionnaires against 16 d dietary records in Japanese adults. *Public Health Nutr* 14: 1200–1211. 2011.
 17. Kobayashi S, Yuan X, Sasaki S, Osawa Y, Hirata T, Abe Y, Takayama M, Arai Y, Masui Y, Ishizaki T. Relative validity of brief-type self-administered diet history questionnaire among very old Japanese aged 80 years or older. *Public Health Nutr* 22: 212–222. 2019.
 18. Malmstrom TK, Morley JE. SARC-F: a simple questionnaire to rapidly diagnose sarcopenia. *J Am Med Dir Assoc* 14: 531–532. 2013.
 19. Kurita N, Wakita T, Kamitani T, Wada O, Mizuno K. SARC-F Validation and SARC-F+EBM Derivation in Musculoskeletal Disease: The SPSS-OK Study. *J Nutr Health Aging* 23: 732–738. 2019.
 20. Japan Society for the Study of Obesity. (in Japanese). Guideline for the management of obesity disease 2022. Life Science Publication. 2022.
 21. Chhetri JK, de Souto Barreto P, Fougère B, Rolland Y, Vellas B, Cesari M. Chronic inflammation and sarcopenia: A regenerative cell therapy perspective. *Exp Gerontol* 103: 115–123. 2018.
 22. Rossi P, Marzani B, Giardina S, Negro M, Marzatico F. Human skeletal muscle aging and the oxidative system: cellular events. *Curr Aging Sci* 1: 182–191. 2008.
 23. Makizako H, Nakai Y, Tomioka K, Taniguchi Y. Prevalence of sarcopenia defined using the Asia Working Group for Sarcopenia criteria in Japanese community-dwelling older adults: A systematic review and meta-analysis. *Phys Ther Res* 22: 53–57. 2019.
 24. Iriondo-Dehond A, Uranga JA, Del Castillo MD, Abalo R. Effects of coffee and its components on the gastrointestinal tract and the brain-gut axis. *Nutrients* 13: 88. 2020.
 25. Lu H, Tian Z, Cui Y, Liu Z, Ma X. Chlorogenic acid: A comprehensive review of the dietary sources, processing effects, bioavailability, beneficial properties, mechanisms of action, and future directions. *Compr Rev Food Sci Food Saf* 19: 3130–3158. 2020.

Supplementary Table 1. The SARC-F Scale

Components	Questions	SARC-F Score
Strength	Did you experience any difficulty in lifting or carrying 10 pounds?	None = 0
		Some = 1
		Great difficulty or unable to lift = 2
Assistance in walking	Did you experience any difficulty in walking across a room?	None = 0
		Some = 1
		Great difficulty, use aids, or unable to walk = 2
Rising from a chair	Did you experience any difficulty in transferring from a chair or bed?	None = 0
		Some = 1
		Great difficulty or unable to transfer without help = 2
Climbing stairs	Did you experience any difficulty in climbing a flight of 10 steps?	None = 0
		Some = 1
		Great difficulty or unable to climb = 2
Falls	Did you experience any falls in the past year?	None = 0
		1–3 falls = 1
		4 or more falls = 2

SARC-F, screening tool for sarcopenia