MEDIA RELEASE

**20 June 2025**

# MORE THAN JUST MENOPAUSE – HOW MUSCLE, FAT AND A SIMPLE BLOOD TEST CAN PREDICT MIDLIFE WOMEN'S HEALTH

*Singapore's longitudinal cohort study of midlife women reveals how muscle strength, visceral fat, and a simple blood test together offer powerful clues to future risk of diabetes, frailty, and physical decline after menopause*

SINGAPORE — New research from the Integrated Women's Health Programme (IWHP) at the National University Hospital (NUH) and the Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine), has uncovered new insights into how muscle strength and visceral fat, and their association with menopause, can potentially lead to downstream health impacts among women in Singapore, and how physical performance assessments and a simple blood test could help predict and prevent chronic conditions before they arise.

The first study, published in *Diabetes, Obesity & Metabolism* in October 2024[1], found that women with both weak muscle strength[2] and high levels of visceral fat had the highest risk of developing prediabetes or type 2 diabetes. Their risk was 2.63 times higher than that of women who had normal muscle strength and lower fat levels.

Having just one of these conditions also increased risk, though to a lesser degree. The risk from having high visceral fat alone is 1.78 times higher. Among those with weak muscle strength, women with high visceral fat had a 2.84 times higher risk compared to those with low visceral fat.

**Professor Yong Eu Leong, Head and Emeritus Consultant, Division of Benign Gynaecology, Department of Obstetrics and Gynaecology, NUH, and the lead of IWHP**, said, "This finding validates our previous research that showed women should not just focus on weight loss, but also on building muscle strength through exercise for diabetes prevention."

The study builds on an earlier 2022 IWHP paper[3] that found midlife women with poor muscle strength had more than double the risk of diabetes compared to those with normal muscle strength.

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[1] Wong BWX, Tan DYZ, Li L-J, Yong E-L. Individual and combined effects of muscle strength and visceral adiposity on incident prediabetes and type 2 diabetes in a longitudinal cohort of midlife Asian women. Diabetes Obes Metab. 2025; 27(1): 155-164. doi:10.1111/dom.15995

[2] Muscle strength Index (MSI) was measured using handgrip strength (HGS) and the five-time repeated chair stand (RCS) test, representing both upper and lower body muscle strength. Women with both poor HGS < 18 kg and/or prolonged RCS ≥12 s were considered to have a 'poor' MSI.

[3] Wong, B. W. X., Thu, W. P. P., Chan, Y. H., Kramer, M. S., Logan, S., Cauley, J. A., & Yong, E.-L. (2022). The Associations between Upper and Lower Body Muscle Strength and Diabetes among Midlife Women. International Journal of Environmental Research and Public Health, 19(20), 13654. https://doi.org/10.3390/ijerph192013654

Women aged 45 to 69 years from Chinese, Malay and Indian ethnic groups were recruited between 2014 to 2016 from the NUH Women's Clinic, now part of the **National University Centre for Women and Children (NUWoC)** – a specialist centre that aims to empower women, children, and their families to lead healthier lives. All participants were healthy at the time of recruitment. The team completed a second follow-up visit at the six-year mark from 2020 to 2023, and a third 12-year follow-up visit is scheduled to start in 2026.

In another recent study, published in *Menopause* in March 2025[4], the team found that a simple hospital blood test could help predict who is more likely to lose muscle mass and physical strength with age. Women with a lower ratio of creatinine to cystatin C (CCR), a marker derived from blood tests to check on skeletal muscle mass and kidney functions, had less muscle and walked more slowly later in life.

This suggested that CCR could be a useful early warning sign for sarcopenia and muscle decline, which may lead to falls, frailty, and reduced quality of life. As a potential screening tool which requires further investigation, CCR is simple, practical and low-cost compared to current methods of measuring muscle, like magnetic resonance imaging scans or strength tests, which are more expensive and time-consuming. CCR could be used to identify at-risk women early and recommend timely interventions.

A commentary by the study team, published in *Annals* in February 2025[5], further highlighted that menopause could lead to body changes in ways that are not always visible. Declining oestrogen during menopause contributes to increased visceral fat and reduced muscle mass – changes not captured by body mass index (BMI). These shifts are linked to greater risks of diabetes, hypertension, osteoporosis, and even early mortality.

The commentary also cited previous IWHP studies, including one published in 2017[6] which noted that weak hand grip strength was independently associated with increased risks of osteoporosis.

Drawing on these findings, the IWHP researchers called this phenomenon the "Janus-like effect" — named after the Roman god of transitions — to describe the life-changing shift from the reproductive period to the post-menopausal stages of life.

"Beyond BMI and reduction of visceral obesity, exercises to improve physical performance and muscle strength have emerged as key lifestyle strategies to extend healthy lifespans for midlife Singaporean women," said Prof Yong. "Targeted implementation programmes consisting of muscle strength exercises is beneficial for midlife women."

The IWHP is an ongoing longitudinal study of midlife women in Singapore funded by the Singapore Ministry of Health through the National Medical Research Council

[4] Tan, Darren Yuen Zhang BEng (Hons)1; Wong, Beverly Wen Xin MPH1; Shen, Liang PhD2; Li, Ling-Jun PhD1,3,4; Yong, Eu-Leong FRCOG, PhD1. Low creatinine to cystatin C ratio is associated with lower muscle volumes and poorer gait speeds in the longitudinal Integrated Women's Health Program cohort. Menopause ():10.1097/GME.0000000000002524, March 18, 2025. | DOI: 10.1097/GME.0000000000002524

[5] Yong EL, Wong BWX, Tan DYZ. Beyond BMI: The Janus-like effect of muscle versus fat on midlife women's health. Ann Acad Med Singap. 2025 Feb 27;54(2):125-128. doi: 10.47102/annals-acadmedsg.2024278. PMID: 40071460.

[6] Logan S, Thu WPP, Lay WK, et al. Chronic joint pain and handgrip strength correlates with osteoporosis in mid-life women: a Singaporean cohort. Osteoporos Int 2017;28:2633-43.

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## Chinese Glossary

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| National University Health System (NUHS) | 国立大学医学组织（国大医学组织） |
| National University Hospital (NUH) | 国立大学医院（国大医院） |
| Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine) | 新加坡国立大学杨潞龄医学院 （国大杨潞龄医学院） |
| National University Centre for Women and Children (NUWoC) | 国大妇幼医疗中心 |
| Professor Yong Eu Leong<br>Head and Emeritus Consultant<br>Division of Benign Gynaecology<br>Department of Obstetrics and Gynaecology<br>National University Hospital | 杨有亮教授<br>主任兼荣誉顾问医生<br>良性妇科部门<br>妇产科<br>国立大学医院 |
| Integrated Women's Health Programme (IWHP) | 女性综合健康计划 |

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## About the National University Health System (NUHS)

The National University Health System (NUHS) aims to transform how illness is prevented and managed by discovering causes of disease, development of more effective treatments through collaborative multidisciplinary research and clinical trials, and creation of better technologies and care delivery systems in partnership with others who share the same values and vision.

Institutions in the NUHS Group include the National University Hospital, Ng Teng Fong General Hospital, Jurong Community Hospital and Alexandra Hospital; three National Specialty Centres - National University Cancer Institute, Singapore (NCIS), National University Heart Centre, Singapore (NUHCS) and National University Centre for Oral Health, Singapore (NUCOHS); the National University Polyclinics (NUP); Jurong Medical Centre; and three NUS health sciences schools – NUS Yong Loo Lin School of Medicine (including the Alice Lee Centre for Nursing Studies), NUS Faculty of Dentistry and NUS Saw Swee Hock School of Public Health.

With member institutions under a common governance structure, NUHS creates synergies for the advancement of health by integrating patient care, health science education and biomedical research.

As a Regional Health System, NUHS works closely with health and social care partners across Singapore to develop and implement programmes that contribute to a healthy and engaged population in the Western part of Singapore.

For more information, please visit www.nuhs.edu.sg.

## About the National University Hospital (NUH)

The National University Hospital (NUH) is Singapore's leading university hospital. While the hospital at Kent Ridge first received its patients on 24 June 1985, our legacy started from 1905, the date of the founding of what is today the NUS Yong Loo Lin School of Medicine. NUH is the principal teaching hospital of the medical school.

Our unique identity as a university hospital is a key attraction for healthcare professionals who aspire to do more than practise tertiary medical care. We offer an environment where research and teaching are an integral part of medicine, and continue to shape medicine and transform care for the community we care for.

We are an academic medical centre with over 1,200-beds, serving more than one million patients a year with over 50 medical, surgical and dental specialities. NUH is the only public and not-for-profit hospital in Singapore to provide trusted care for adults, women and children under one roof, including the only paediatric kidney and liver transplant programme in the country.

The NUH is a key member of the National University Health System (NUHS), one of three public healthcare clusters in Singapore.

## About the NUS Yong Loo Lin School of Medicine (NUS Medicine)

The NUS Yong Loo Lin School of Medicine is Singapore's first and largest medical school. Our enduring mission centres on nurturing highly competent, values-driven and inspired healthcare professionals to transform the practice of medicine and improve health around the world.

Through a dynamic and future-oriented five-year curriculum that is inter-disciplinary and inter-professional in nature, our students undergo a holistic learning experience that exposes them to multiple facets of healthcare and prepares them to become visionary leaders and compassionate doctors and nurses of tomorrow. Since the School's founding in 1905, more than 12,000 graduates have passed through our doors.

In our pursuit of health for all, our strategic research programmes focus on innovative, cutting-edge biomedical research with collaborators around the world to deliver high impact solutions to benefit human lives.

The School is the oldest institution of higher learning in the National University of Singapore and a founding institutional member of the National University Health System. It is one of Asia's leading medical schools and ranks among the best in the world (Times Higher Education World University Rankings 2025 by subject and the Quacquarelli Symonds (QS) World University Rankings by subject 2025).

For more information about NUS Medicine, please visit https://medicine.nus.edu.sg/.

## About the National Medical Research Council (NMRC)

The NMRC was established in 1994 to oversee research funding from the Ministry of Health and support the development and advancement of biomedical research in Singapore, particularly in the public healthcare clusters and medical schools. NMRC engages in research strategy and planning, provides funding to support competitive research grants and core research enablers, and is responsible for the development of clinician scientists through awards and fellowships. The council's work is supported by the NMRC Office which is part of MOH Holdings Pte Ltd. Through its management of the various funding initiatives, NMRC promotes healthcare research in Singapore, for better health and economic outcomes

**Annex – Key findings**

**Title: Individual and combined effects of muscle strength and visceral adiposity on incident prediabetes and type 2 diabetes in a longitudinal cohort of midlife Asian women**
Publication: Diabetes, Obesity and Metabolism
Date: 4 October 2024
Link: https://dom-pubs.pericles-prod.literatumonline.com/doi/abs/10.1111/dom.15995

- Among the 733 IWHP participants who had normal blood sugar levels at the time of recruitment, 150 (20.5%) developed prediabetes or type 2 diabetes after a 6.6-year follow-up.

- Women with both poor combined muscle strength and high visceral fat had the highest risk for developing prediabetes and type 2 diabetes, with a risk of 2.63 times higher than those with normal muscle strength and low visceral fat.

- In comparison, high visceral fat alone increased risk by 1.78 times.

- Among women with low muscle strength, those with high visceral fat had a 2.84 times higher risk compared to those with normal visceral fat. Among women with normal muscle strength, those with high visceral fat had a 1.66 times higher risk.

Conclusions:

- Low combined muscle strength with high visceral fat poses a greater risk for the development of prediabetes and type 2 diabetes than high visceral fat alone.

- Muscle strengthening should be promoted alongside weight loss in diabetes prevention.

**Title: Low creatinine to cystatin C ratio is associated with lower muscle volumes and poorer gait speeds in the longitudinal Integrated Women's Health Program cohort**
Publication: Menopause
Date: 18 March 2025
Link:
https://journals.lww.com/menopausejournal/abstract/9900/low_creatinine_to_cystatin_c_ratio_is_associated.440.aspx

- Among the IWHP cohort, 891 participants underwent muscle strength and physical performance assessments and MRI scans at the time of recruitment and again at a 6.6-year follow-up. The findings were independent of age, ethnicity, education level, menopause status, smoking, alcohol consumption, visceral fat, hormone therapy use, statins (cholesterol-lowering drugs) use, and inflammatory markers.

- Women with a low creatinine to cystatin C ratio (CCR) had a lower mean fat-free thigh muscle volume (by 0.35 litres) compared to those with a high CCR.

- Similarly, the low CCR group had slower mean usual gait speeds (by 0.029 milliseconds) and slower mean narrow gait speeds (by 0.049 milliseconds) compared to the high CCR group.

- Participants with low CCR also demonstrated weaker muscle strength and poorer physical performance, based on lower handgrip strength and shorter one-leg stand times.

Conclusion:

- Low CCR at baseline was associated with lower fat-free muscle volumes and poorer gait speeds (both of which are constituents of current diagnostic criteria of sarcopenia) 6.6 years later.

- The potential of CCR as a predictive biomarker for adverse events related to sarcopenia in midlife women merits further investigation.