

Metabolic health and strategies for a Healthier SG

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Abstract

This review examines strategies for the prevention and management of obesity, hypertension, type 2 diabetes mellitus and dyslipidaemia, conditions that are increasing in Singapore, as components of individualised health plans in 'Healthier SG' and beyond. We describe cardiometabolic disease prevention and management initiatives in Changi General Hospital (CGH), including collaborations with SingHealth Polyclinics, Active SG, Exercise is Medicine Singapore and community partners in the Eastern Community Health Outreach programme, and highlight advances in curable hypertension (e.g., primary hyperaldosteronism) and novel cardiovascular risk markers such as lipoprotein(a). We also outline technology-based interventions, notably the CGH Health Management Unit, which demonstrate the utility and convenience of telemedicine, and digital therapeutics in the form of apps that have been shown to improve treatment adherence and clinical outcomes. Individual empowerment, in partnership with community and healthcare providers and supported by research and innovation of care delivery, is key to building a healthier and stronger nation.

Keywords: Diabetes mellitus, dyslipidaemia, hypertension, metabolic syndrome, obesity

INTRODUCTION

As Singapore enters its 60th year, an ageing population and higher rates of obesity and chronic disease pose major challenges to its healthcare system. By 2030, a quarter of Singaporeans will be aged 65 years and above,^[1] with 26% of the population in Singapore's Eastern region already aged 60 years and above in 2023.^[2] Obesity, a state of excess adiposity associated with impairment of organ dysfunction and a driver of chronic diseases — including diabetes mellitus (DM), hypertension, dyslipidaemia, metabolic dysfunction-associated liver disease (MASLD), obstructive sleep apnoea (OSA), musculoskeletal conditions, psychological disorders and cancers^[3,4] — is also on the rise. According to the National Population Health Survey 2022, the prevalence of obesity, as defined by the World Health Organization as a body mass index (BMI) ≥ 30 kg/m², increased from 8.6% to 11.6%.^[5] More than a quarter of Singaporean adults aged 40–59 years had a BMI ≥ 27.5 kg/m², which is associated with increased risks of DM and cardiovascular disease (CVD) in Asian populations.^[6] The latter, which encompasses coronary heart disease, heart failure, stroke, peripheral artery disease and abdominal aortic

aneurysm, remains the leading cause of morbidity and mortality in Singapore.^[7] The proportion of disability-adjusted life years attributable to overweight and obesity increased from 3.9% in 1990 to 6.4% in 2017, making these conditions the fifth leading risk factor for poor health in Singapore.^[8] It is, therefore, imperative to prioritise improvements in cardiometabolic health, rather than reactively managing the consequences of undiagnosed and untreated chronic disease.

Healthier SG, a major initiative that focuses on preventive care including health screening and vaccinations, engages community partners to promote healthier lifestyles. It involves primary care physicians (PCPs) in the implementation of individualised health plans incorporating lifestyle modification and chronic disease prevention, especially with the use of

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technology,^[1] and is coordinated by Singapore's three healthcare clusters (National Health Group, National University Health System and SingHealth) in their respective regions. Within SingHealth, Changi General Hospital (CGH) partners with SingHealth Polyclinics (SHPs), general practitioners in the Primary Care Network and community stakeholders such as Active SG, East Coast town councils and the People's Association to meet the health needs of the 748,000 residents in the Eastern region.^[2] In this review, we discuss strategies for chronic disease prevention through weight management and the timely diagnosis and treatment of CVD risk factors, with a focus on primary care and individual empowerment.

Weight management: health plans and holistic programmes

Primary care physicians are well positioned to leverage on trusted lifelong relationships to engage with individual patients and their families for weight management and collaborate with community partners who play key roles in supporting healthy lifestyles. Doctors at SHPs use the national BMI control framework^[9] [Figure 1] to assess for obesity and its complications and to co-formulate weight management strategies through the Health Plan discussion^[1] with patients soon after enrolment in Healthier SG. Each Health Plan takes into consideration lifestyle factors, comorbidities and CVD targets, and is updated annually or more frequently depending on patient needs and preferences. In the green zone, where patients are well with no cardiovascular (CV) comorbidities,

the emphasis is on self-empowerment and activation. Residents can join community exercise and nutritional programmes organised by the Health Promotion Board (HPB), Active SG and Active Health (<https://www.activesgcircle.gov.sg/activehealth>), which offer affordable exercise programmes. Active Health coaches in nine Active Health Labs island-wide provide assessment tools, advice and coaching programmes through e-workshops and in person for patients keen to adopt lifestyle changes. In addition, the Healthy 365 app uses gamification to motivate residents to adopt healthy habits and lifestyles. The app allows users to track lifestyle changes and rewards them with points for engaging in healthy activities.^[10]

Conversations about weight management are initiated with individuals with higher BMI (orange zone). Using the five 'Using the five 'A's framework for counselling,^[11] physicians Ask patients in a non-judgemental and respectful manner for permission to discuss their weight and readiness for change; Assess drivers and obesity-related complications; Advise on the risks of ongoing weight gain and on the benefits of weight loss; Agree on realistic weight goals, behavioural changes and further treatment options; and Assist in overcoming barriers, providing support and resources while arranging follow-ups.^[12] This framework is easy to implement^[13] and more effective for weight loss compared to unstructured consultations.^[14] Care managers (nurses) and dietitians provide additional advice for dietary modification, emphasising a daily calorie reduction of approximately 500 kcal below estimated daily requirements, using

BMI Control Management Framework for 18- to 65-year-olds

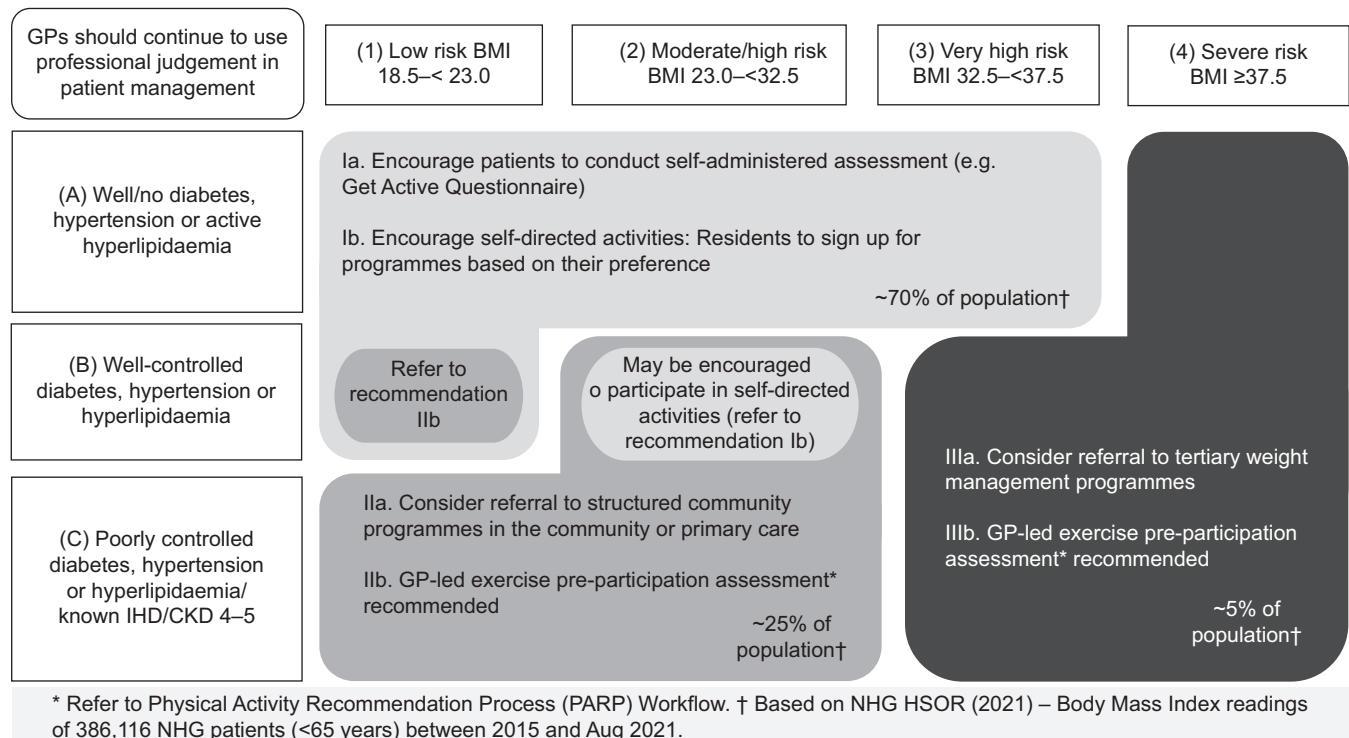


Figure 1: National BMI Control Management Framework for primary care patients aged 18–65 years.

a diet that can be adhered to in the long term,^[15] rather than specific diets (e.g., ketogenic, Mediterranean or paleo diet), which may be difficult to follow locally and/or lead to nutrient deficiencies,^[16] or intermittent fasting, which may be socially restrictive.^[15]

Physical activity is an integral component of the Health Plan, with sedentary individuals encouraged to start with low-intensity activities (e.g., walking or chair-based exercise) and increase gradually as tolerated, targeting at least 150–300 min of moderate-intensity aerobic exercise or 75–150 min of vigorous aerobic exercise for at least 4–5 days/week, together with strength training exercises for 2 days or more.^[17] Primary care physicians trained in exercise clearance are well placed to support safe transition to exercise in the community. In addition, the ‘Exercise is Medicine Singapore’ (part of the global ‘Exercise is Medicine’ initiative managed by the American College of Sports Medicine) courses, which are conducted by CGH sports medicine specialists and family physicians, train healthcare workers and fitness professionals in exercise prescription for cardiometabolic disease and musculoskeletal conditions.^[18]

Individuals with a BMI ≥ 32.5 kg/m² who are at high risk of developing obesity-related comorbidities, or who have been diagnosed with cardiometabolic disease (red zone), can be referred to tertiary centres for more intensive multidisciplinary weight management programmes. These programmes, usually spanning 6 months, are run by physicians and include dietitians, exercise physiologists and other allied health services (such as psychologists), as required, through in-person consultations, group sessions and teleconsults. These are tailored to patient needs with the goal of achieving at least 10% weight loss and improvement in comorbidities. SingHealth Polyclinics is exploring a similar multidisciplinary weight management programme anchored by doctors, nurses and dietitians in a primary care setting. As obesity is a multifactorial, chronic and relapsing disease,^[19] pharmacotherapy and bariatric endoscopic and surgical procedures may be necessary depending on individual needs and disease severity.^[3,4,19] Anti-obesity medications may be considered for individuals with a BMI ≥ 30 kg/m², or those with a BMI ≥ 27 kg/m² with obesity-related comorbidities^[20]; all medications currently approved for weight loss in Singapore (phentermine,^[21] orlistat,^[22] naltrexone–bupropion,^[23] glucagon-like peptide-1 [GLP-1] receptor agonists^[24–26]) are appetite suppressants, except for orlistat, which inhibits dietary fat absorption, and are used as adjuncts to lifestyle modification to induce additional 5%–10% weight loss.^[19,20] In particular, injectable GLP-1 receptor agonists (liraglutide, semaglutide) have also been effective in improving MASLD^[27,28] and OSA.^[29] For more severe obesity, metabolic bariatric surgeries (laparoscopic sleeve gastrectomy, gastric bypass),^[30] which induce a weight loss of $\geq 25\%$ –30%, with more effective and durable remission of DM,^[31] improve MASLD,^[32] OSA^[33] and other obesity-related comorbidities.^[34] While smaller degrees of weight loss are

associated with less-invasive endoscopic bariatric procedures such as intragastric balloons (16% at 10 months)^[35] and endoscopic gastroplasty (13%–20% at 12 months),^[36] benefits for weight reduction and associated comorbidities are still more sustainable^[30,31] compared to those achieved with lifestyle modification or medications alone. However, owing to financial costs, surgical risks (although low) and long-term complications such as nutritional deficiencies,^[30] surgery is still perceived as the last resort for most people living with obesity, underscoring the importance of intervention at an earlier stage of disease.

Screening and management of cardiovascular risk factors: the three ‘highs’ and beyond

Hypertension: cause, compliance and cure

Globally, hypertension affects more than 1 billion individuals. In Singapore, with an adult population of 4.93 million, the prevalence of hypertension increased from 19.8% in 2010 to 37.0% in 2021–2022.^[37] Despite effective treatment for hypertension widely available, more than 875,000 individuals have uncontrolled hypertension,^[5,37] contributing to significant healthcare costs and socioeconomic burden. The global medical costs of treating hypertension are estimated at USD 370 billion per year. However, healthcare savings from effective management of blood pressure (BP) are projected at USD100 billion per year.^[38] Important causes of poor BP control are undiagnosed hypertension, medication non-adherence and treatment inertia. As patients with hypertension are largely asymptomatic, screening for elevated BP by a dedicated family physician and regular visits to a family physician, as recommended in Healthier SG, are essential for timely diagnosis and treatment.

In patients with known hypertension, maintaining medication adherence is challenging. Failure to recognise non-adherence can lead to unnecessary tests or unnecessary escalation of therapy, which can lead to low BP.^[39,40] Detecting non-adherence is challenging, as commonly used approaches, such as patient recall, questionnaires, pill counting boxes, electronic monitoring devices and pharmacy records, are time-consuming and potentially inaccurate.^[41] Urine adherence testing has been shown to improve adherence in patients by 70%, with an improvement in systolic BP by 20 mmHg.^[42] The International Society of Hypertension^[43] recommends direct biochemical methods such as urine testing for the presence of antihypertensive drugs over subjective methods to diagnose non-adherence. A cost-effectiveness analysis demonstrated that the implementation of such testing in 10,000 patients could prevent 518 myocardial infarctions and 305 stroke events, at a reduced cost of GBP 5 million or more.^[44] Urine adherence testing for antihypertensive medications is currently being tested in Singapore in a collaborative study between CGH, Tan Tock Seng Hospital and SHPs (ClinicalTrials.gov NCT: 06938633).

While most individuals with hypertension have essential hypertension, many have primary aldosteronism (PA), a treatable underlying condition. In Singapore, the prevalence of PA is estimated at 5% in primary care, 13% in tertiary clinics and 30% among patients with stroke and atrial fibrillation.^[45-47] Aldosterone-driven hypertension may be even more common and may explain age-related elevations in BP.^[48] Patients with PA have a two-fold higher risk of CVD and renal dysfunction compared to those with essential hypertension.^[49] Furthermore, about 50% of these patients have a unilateral adrenal adenoma (Conn's syndrome), which can be cured with laparoscopic surgery.^[50] Complete cure of hypertension is more likely in younger patients and in those with a shorter duration of hypertension, highlighting the importance of early diagnosis. In Singapore, however, 50% of patients with PA have prolonged hypokalaemia for more than a year before being referred and diagnosed.^[51] To address this gap, the 2024 European Society of Cardiology recommends screening all patients with hypertension for PA at least once.^[52] Until aldosterone testing becomes widely available in the primary care setting, we would recommend specialist endocrine referral for patients at high risk for PA, especially those with hypertension and hypokalaemia (including diuretic-induced hypokalaemia), severe hypertension (BP $\geq$ 160/100 mmHg) or resistant hypertension. In the CGH Adrenal Hypertension Centre, in collaboration with all restructured hospitals in Singapore, significant progress has been made, offering reasons for optimism. First, the diagnosis of patients has increased over the last decade, which is a testament to increased awareness among physicians.^[51] Second, advances in diagnostic tools, including radiological tests, functional imaging and biomarkers, have improved the detection of patients with curable disease.^[53,54] Finally, local patients treated for PA have demonstrated not only improved BP but also better cardiac function and quality of life.^[55,56] With the development of aldosterone synthase inhibitors, treatment of hyperaldosteronism may become more convenient and cost-effective.^[57] As much as 80% of CVD could be prevented or postponed if risk factors in lifestyle and behaviour could be eliminated.^[58]

Diabetes mellitus

The prevalence of DM, a major CVD risk factor, doubles with age in Singapore, from 5% at age 40–49 years to about 11% at 50–59 years and >20% in those aged 60 years and above.^[5] Nearly all cases are type 2 DM due to insulin resistance associated with ageing and obesity. Prediabetes affects 14% of the population, with approximately 35% progressing to DM within 8 years.^[59] Insulin resistance represents a continuum from prediabetes to DM, providing opportunities to intervene at an earlier stage to halt progression to or even reverse DM. Screening is offered annually in SHP, with fasting glucose (6.1–6.9 mmol/L) or glycated haemoglobin (HbA1c; 6.1%–6.9%) indicating the need for oral glucose tolerance test to diagnose prediabetes (2-h glucose 7.8–11.0 mmol/L)

or DM (2-h glucose $\geq$ 11.1 mmol/L). Evidence shows that prediabetes can be reversed by lifestyle modification with or without medications such as metformin,^[60] acarbose^[61] and pioglitazone.^[62] In SHP, metformin may be initiated for patients with prediabetes and HbA1c persistently above 6.0% despite 6 months of lifestyle intervention. Remission of type 2 DM has also been demonstrated in the Look AHEAD (Action for Health in Diabetes) study,^[63] the UK Diabetes Remission Clinical Trial employing caloric restriction and meal replacements,^[64] the Diabetes Intervention Accentuating Diet and Enhancing Metabolism-I study in Middle Eastern and North African populations,^[65] and in primary care clinics in Australia.^[66] As noted above, bariatric surgery has demonstrated even greater efficacy and durability of remission of DM,^[31] but is less widely accepted and available.

Dyslipidaemia

The Agency for Care Effectiveness Clinical Guidance for Lipid Management,^[67] published in December 2023, provides risk-stratified lipid-lowering recommendations to guide prescription of medications. Chronic kidney disease, DM or familial hyperlipidaemia confer the highest risk, and in the absence of these factors, the 10-year CVD risk is calculated using the Singapore-modified Framingham Risk Score (SG-FRS-2023) to guide the prescription of medications. Similar to weight management, the five 'A's framework is recommended for lifestyle intervention, incorporating diet, exercise, smoking cessation and limited alcohol intake.^[68] Statins are recommended for patients with intermediate (SG-FRS-2023 10%–20%) or high (>20%) risk of CVD, with the addition of ezetimibe, proprotein convertase subtilisin/kexin type 9 inhibitors and/or inclisiran to achieve even lower low-density lipoprotein (LDL) targets in patients at very high risk of CVD.^[67] Notably, genetic testing for familial hyperlipidaemia allows for better individualised care, prognostication and cascade testing of family members.^[67] Importantly, certain risk enhancers, such as metabolic syndrome and premature menopause, and additional markers of CVD risk, such as abnormal ankle–brachial index^[69] and elevated lipoprotein(a) [Lp(a)],^[70] indicate a higher risk for CVD than that calculated with SG-FRS, necessitating tighter control of risk factors and intensification of pharmacotherapy, particularly statins. Elevated Lp(a) is genetically determined^[70] and affects 20% of the global population, with prevalence varying across ethnicities.^[71] Elevated Lp(a) $\geq$ 120 nmol/L (50 mg/dL) affects approximately 10% of the Singaporean population^[72] and was found in 17% of patients with ischaemic heart disease in CGH.^[73] To address this, CGH has developed an implementation, awareness and educational strategy known as the LILAC-for-Lp(a) approach, which encompasses five key salient points of management developed from expert opinion and clinical studies.^[70,71,74,75] LILAC stands for: L = Lp(a), a CV risk enhancer; I = Improve control of all modifiable CV risk factors; L = Lower LDL and Lp(a) concentrations; A = Assess for conditions related to elevated Lp(a), including aortic

valve stenosis and the role of aspirin for atherosclerosis; and C = Cascade testing for Lp(a) if the index case has very high Lp(a) or familial hypercholesterolaemia. The LILAC-for-Lp(a) concept has been presented in CGH, cardiology conferences, virtual educational talks (<https://youtu.be/HmAGs2s9G0g?si=GzsOcnUsbdNSdE>), physical workshops and at Singapore's inaugural Lp(a) Awareness Day in April 2024. A pilot study involving 500 healthcare professionals in CGH showed that the #LILAC-for-Lp(a) concept disseminated by a short educational video was very well received and could be part of a sustainable implementation strategy.^[76]

Community screening

While these strategies for screening and management of CVD risk factors are available to individuals enrolled in Healthier SG, it is concerning that the 2022 National Population Health survey found that significant numbers had not been diagnosed before the survey, representing a major gap in treatment: DM in 18.8% of residents, hyperlipidaemia in 46.8% and hypertension in 53.3%.^[5] Barriers to health screening persist even in our geographically compact, urban, relatively literate and connected nation; low socioeconomic status (e.g., staying in rental flats) and education levels were associated with poor participation in health screening.^[77,78] On the other hand, 88% of participants were more likely to attend screening if a follow-up was arranged by the screening centre, and up to 70% were more likely to participate if screening was free of charge, held on weekends and allowed family or friends to accompany them.^[79] In 2011, CGH launched the Eastern Community Health Outreach (ECHO) community screening programme^[80] for residents of the Eastern region of Singapore aged 40 years

and above who had not undergone any health screening in the last 3 years. Free annual screening events were conducted on weekends in conjunction with activities such as health talks and nutritional education at community centres situated in the Changi–Simei area, subsequently expanding to Tampines, Pasir Ris, Bedok, Marine Parade and other constituencies in the East. With the support and participation of the Health Promotion Board,^[80] community centres and health champions, cooking sessions, communal walks and other activities were also regularly organised. Participants with abnormal screening results were provided with a referral letter for follow-up treatment with their PCPs. ECHO also publishes a quarterly newsletter along with annual mail invitations to encourage participants to return for health screening. Participation in ECHO has been associated with strengthened healthcare beliefs and healthier lifestyle behavioural changes, with a general trend towards reductions in weight, waist circumference, BP, glucose and cholesterol [Figure 2, unpublished data]. Affordable screening and complimentary lifestyle interventions may improve population health through encouraging early detection and fostering of healthier lifestyle behaviours.

Digital therapeutics: medicine without meds

The use of telemedicine as a complement to physical visits can enhance patients' engagement and adherence to health plans and medications at their convenience, provide more flexible and personalised delivery of care and reduce the pressure on healthcare systems.^[81,82] A recent qualitative survey in Singapore found that participants viewed virtual consults as convenient and safe but deemed the absence of physical examination, digital health illiteracy and additional

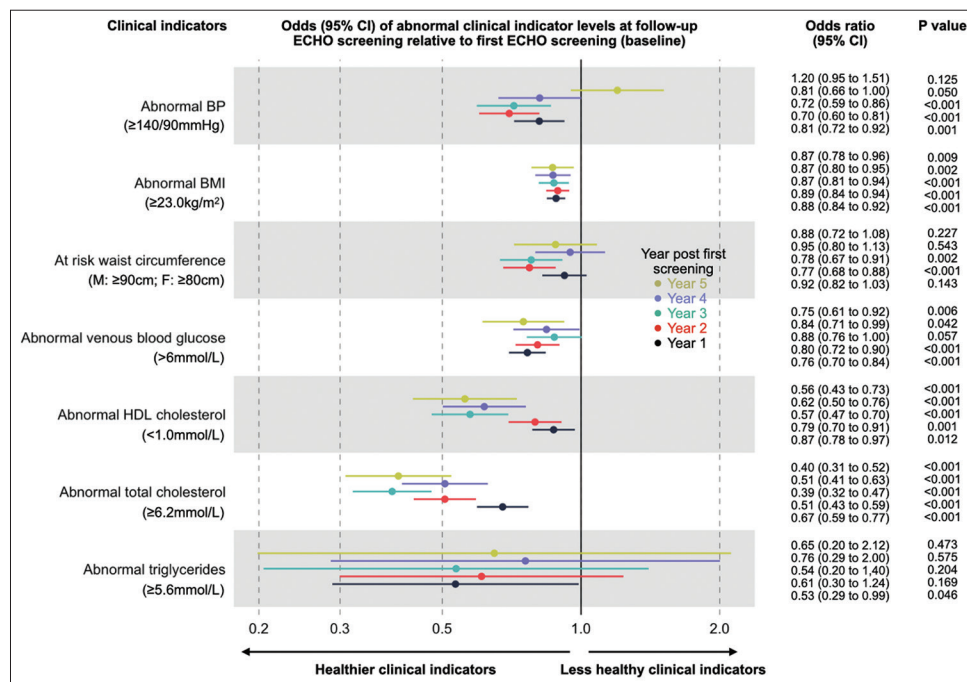


Figure 2: Effect of participation in the Eastern Community Health Outreach programme on chronic disease indicators over a 5-year period.

expenses as challenges. The authors advocated a hybrid clinical care model comprising in-person and teleconsultation for non-communicable diseases.^[83] Ahead of the accelerated adoption of telemedicine during the coronavirus disease 2019 pandemic, the CGH Health Management Unit was established in 2011 to improve patient support and education in DM.^[84] The unit consists of trained telecarers who schedule follow-up phone calls with patients incorporating education modules (curated by endocrinologists, dietitians and DM nurse educators) on DM management and self-care. This programme was demonstrated to improve DM control^[84] and was expanded to include other chronic diseases such as heart failure and osteoporosis.

Behavioural modification is key to achieving successful weight loss and requires sustained efforts.^[85] Regular reminders for self-monitoring and goals, and advice on diet, exercise, stimulus control, sleep hygiene and stress reduction — delivered through mobile apps in familiar and relevant environments and situations — could maintain a constant level of commitment to weight loss that wanes between contacts with healthcare providers.^[86] While conclusions about the effects of apps versus standard/minimal interventions are limited by variability in app features, content and components, which limits direct comparison,^[87] an increasing number of ongoing studies suggest that more evidence will be available in coming years as users become familiar with mobile health interventions. Locally, apps such as Healthy365^[10] and nBuddy Diabetes^[88] have been developed to deliver nudges and information about DM and weight management. However, the main barriers to the wider use of these apps are lack of digital literacy, reluctance (both healthcare providers and patients) to use the apps, lack of oversight for specific health advice and the risk of ‘nudge fatigue’.^[89,90] The EMPOWER app developed in collaboration between SingHealth and the National University of Singapore uses open-source development frameworks, secure cloud architectures, widely available behaviour tracking solutions (e.g., Fitbit) and plug-and-play packaging with modular technology.^[91,92] Since its rollout in 2021, EMPOWER has been tested in a large randomised clinical trial involving 1000 patients with DM at SHP, with interim analysis demonstrating increased physical activity and a statistically significant reduction in HbA1c at 3 months and sustained improvements at 12 months.^[93]

CONCLUSION

In the 21st century, Singapore, like other developed societies, faces similar increases in cardiometabolic disease attributed to an ageing population, lifestyle changes and increased prevalence of overweight and obesity. Weight management, early detection and effective treatment of the risk factors for CVD are essential. Community health initiatives; screening and regular follow-up for hypertension, DM and hyperlipidaemia with a dedicated family physician in Healthier SG; and continuous research and innovation for improving healthcare delivery and developing novel treatments are key strategies

for the prevention and treatment of chronic diseases. Together, these efforts will be critical in building a stronger and healthier Singapore.

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Conflicts of interest

How CH and Puar THK are members of the SMJ Editorial Board and were, thus, not involved in the peer review or publication decision of this article.

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