

Appendix 1: Methods

Anthropometric and biochemical assessments

In each wave, body weight and height were measured twice for each participant, who was barefoot and dressed in light clothing, using an automated anthropometer (Shengyuan Co., Ltd., Zhengzhou, China; HGM-300). The mean values were calculated to determine the BMI (kg/m^2). WC was measured 1 cm above the umbilicus following exhalation with a non-stretchable tape, and the average of two measurements was recorded. BP was measured on the right arm with participants seated and resting quietly for at least 5 minutes, using a validated oscillometric device (Omron HEM-7012 in Waves 1 and 2, Omron HEM-1300 in Waves 3 and 4). Three readings were obtained, and the last two were averaged for analysis. Fasting blood samples (after a 10-hour fast) were used to assess high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and fasting plasma glucose (FPG) levels, which were analyzed with an automated biochemistry analyzer (Cobas c702, Mannheim, Germany).

Ultrasonography examinations

Hepatic steatosis was evaluated in all four surveys by a certified sonographer using a portable Doppler ultrasound system (CX30, Philips) equipped with a 2–6 MHz convex array transducer. The sonographer was blinded to participants' clinical data. Examinations were performed with participants in the supine position and both upper limbs raised to optimize access to the intercostal echocardiographic window. Hepatic steatosis was diagnosed based on characteristic sonographic features, including increased hepatorenal echo contrast, elevated liver brightness, deep attenuation, and vascular blurring (8).

cIMT was measured on the far wall of both the left and right common carotid arteries, approximately 10 mm proximal to the bifurcation, using a 4–12 MHz linear array transducer. The mean of both sides was used for analysis. High cIMT was defined as values \geq the 90th age- and sex-specific percentiles of the study population.

Left ventricular dimensions were assessed by two-dimensional guided M-mode echocardiography using a 2–4 MHz transducer. Left ventricular mass (LVM) was calculated using Devereux's formula (9), and the LVM index (LVMI; $\text{g}/\text{m}^{2.7}$) was obtained by adjusting LVM to height^{2.7} (10). LVH was defined as LVMI \geq the 90th age- and sex-specific percentiles of the study population.

Definitions of complex and simplified MASLD

Under the complex criteria, MASLD was defined as the presence of hepatic steatosis plus at least one of the following cardiometabolic risk factors: excessive adiposity (BMI \geq 85th percentile for age and sex or WC $>$ 95th percentile), high BP (SBP/DBP \geq 95th percentile for sex, age and height or \geq 130/80 mmHg for age $<$ 13 years, or \geq 130/85 mmHg for age \geq 13 years), elevated TG (TG \geq 1.15 mmol/L for age $<$ 10 years or \geq 1.70 mmol/L for age \geq 10 years), decreased HDL-C (HDL-C \leq 1.0 mmol/L), and impaired FPG (FPG \geq 5.6 mmol/L). Under the simplified criteria, excessive adiposity was defined as WHtR \geq 0.46, and high BP as SBP/DBP \geq 120/80 mmHg for age 6–12 years or \geq 130/80 mmHg for age 13–17 years. All other components were defined identically to those in the complex criteria.

Covariates assessments

Potential covariates included baseline [2021] age (continuous), sex (boys *vs.* girls), pubertal status (yes *vs.* no), sleep duration (age \leq 12 years: $<$ 9 *vs.* \geq 9 hours/day; age $>$ 13 years: $<$ 8 *vs.* \geq 8 hours/day) (11), screen time ($>$ 2 *vs.* \leq 2 hours/day) (12), and fruit and vegetable intake ($<$ 5 *vs.* \geq 5 servings/day) (13). These data were collected using standardized questionnaires.

Statistical analysis

The prevalence of MASLD was calculated at each wave according to both the complex and simplified definitions. Agreement between the two definitions was assessed using Cohen's kappa statistic. Subgroup analyses were performed by sex and age

groups. Multivariable logistic regression models were used to examine the association between MASLD at baseline (defined by either the complex or simplified criteria) and subclinical cardiovascular damage at follow-up, including high cIMT and LVH. All models were adjusted for baseline age, sex, pubertal status, sleep duration, screen time, and fruit and vegetable intake. ORs and 95% CIs were reported. Statistical analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA), and a two-tailed $P < 0.05$ was considered statistically significant.

References

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- WHtR ≥ 0.46 for Asia, Africa and South America **OR** ≥ 0.50 for Europe and U.S.
- SBP/DBP $\geq 120/80$ mmHg for age 6-12 years **OR** $\geq 130/80$ mmHg for age 13-17 years **OR** anti-hypertensive treatment
- Fasting plasma glucose ≥ 5.6 mmol/L **OR** plasma glucose ≥ 11.1 mmol/L **OR** 2-hour post-load glucose ≥ 7.8 mmol/L **OR** HbA1c $\geq 5.7\%$ **OR** diagnosed type 2 diabetes **OR** anti-diabetic treatment
- Plasma TG ≥ 1.15 mmol/L for age < 10 years **OR** ≥ 1.70 mmol/L for age ≥ 10 years **OR** anti-lipid treatment
- Plasma HDL-C ≤ 1.0 mmol/L **OR** anti-lipid treatment

Figure S1 Simplified MASLD definition in youths. DBP, diastolic blood pressure; HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; MASLD, metabolic dysfunction-associated steatotic liver disease; SBP, systolic blood pressure; TG, triglycerides; U.S., United States; WHtR, waist-to-height ratio.

Table S1 Prevalence of MASLD based on simplified definition vs. complex definition in four cross-sectional surveys (Waves 1 to 4) by sex and age groups

Subgroup	Simplified definition	Complex definition
Wave 1		
Sex		
Boys	17 (2.3)	17 (2.3)
Girls	1 (0.2)	1 (0.2)
Age (years)		
6–8	2 (0.3)	2 (0.3)
9–11	16 (2.2)	16 (2.2)
Wave 2		
Sex		
Boys	26 (4.0)	26 (4.0)
Girls	1 (0.2)	1 (0.2)
Age (years)		
8–10	11 (1.5)	11 (1.5)
11–13	16 (3.2)	16 (3.2)
Wave 3		
Sex		
Boys	46 (6.6)	46 (6.6)
Girls	6 (1.0)	6 (1.0)
Age (years)		
10–12	29 (4.1)	29 (4.1)
13–15	23 (3.7)	23 (3.7)
Wave 4		
Sex		
Boys	76 (12.6)	76 (12.6)
Girls	15 (2.7)	15 (2.7)
Age (years)		
12–14	48 (7.5)	48 (7.5)
15–17	43 (8.3)	43 (8.3)

Data are expressed as n (%). MASLD, metabolic dysfunction-associated steatotic liver disease.