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Anwar Lubis

anwar.lubis@unm.ac.id

Universitas Negeri Makassar

Ismi Irifiyanti Fachruddin

Universitas Negeri Makassar

Andi Hardianti

Universitas Negeri Makassar

Sakinah Amir

Universitas Negeri Makassar

Ulfa Diya Atiqa

Universitas Negeri Makassar

Syamsuriah Syamsuriah

Universitas Negeri Makassar

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Cholesterol Screening Behaviour and Dietary Risk Patterns among Indonesian Adults: A National Analysis

Anwar Lubis[a,*] · Ismi Irifiyanti Fachruddin[b] · Andi Hardianti[b] · Sakinah Amir[b] · Ulfa Diya Atiqa[c] · Syamsuriah Syamsuriah[d]

[a] Culinary Art Study Program, Department of Tourism and Hospitality, Faculty of Engineering, Universitas Negeri Makassar, Makassar, South Sulawesi, 90223, Indonesia

[b] Culinary Art Vocational Education Study Program, Department of Tourism and Hospitality, Faculty of Engineering, Universitas Negeri Makassar, Makassar, South Sulawesi, 90223, Indonesia

[c] Family Welfare Education Study Program, Department of Tourism and Hospitality, Faculty of Engineering, Universitas Negeri Makassar, Makassar, South Sulawesi, 90223, Indonesia

[d] Design Fashion Vocational Education Study Program, Department of Tourism and Hospitality, Faculty of Engineering, Universitas Negeri Makassar, Makassar, South Sulawesi, 90223, Indonesia

Corresponding author

[*] Anwar Lubis, Culinary Art Study Program, Department of Tourism and Hospitality, Faculty of Engineering, Universitas Negeri Makassar, Parang Tambung Street, Makassar, South Sulawesi, 90223, Indonesia. E-mail: anwar.lubis@unm.ac.id

ORCID

Anwar Lubis: 0000-0002-7984-8025

Author contributions

Conceptualization: Anwar Lubis; Methodology: Sakinah Amir; Investigation: Andi Hardianti; Software: Ismi Irifiyanti Fachruddin; Data curation: Ismi Irifiyanti Fachruddin; Formal analysis: Anwar Lubis, Ismi Irifiyanti Fachruddin; Supervision: Ulfa Diya Atiqa, Syamsuriah Syamsuriah; Writing – original draft preparation: Anwar Lubis; Writing – review and editing: Anwar Lubis, Sakinah Amir, Andi Hardianti, Ulfa Diya Atiqa, Syamsuriah Syamsuriah.

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Cholesterol Screening Behaviour and Dietary Risk Patterns among Indonesian Adults: A National Analysis

Abstract

Purpose: Dyslipidemia has no dedicated diagnosis question in Indonesia's national health survey, so self-reported cholesterol screening is the only national indicator of engagement with lipid risk assessment. We estimated the prevalence of never having had cholesterol checked and its association with dietary risk patterns and with sociodemographic, anthropometric and comorbidity correlates.

Methods: We analysed cross-sectional data for 616,111 directly interviewed adults aged 15 years and older from all 38 provinces in the 2023 Indonesian Health Survey. Ten-item risky and four-item prudent dietary scores were built from food-frequency items. Survey-weighted logistic regression with cluster-robust standard errors estimated adjusted correlates of never having been screened.

Results: Nationally, 66.6% of adults had never had cholesterol checked, versus 35.1% for blood pressure and 65.9% for blood glucose. Never having been screened was associated with lower education (adjusted odds ratio for no or incomplete primary versus diploma-level education 2.95, 95% confidence interval 2.78–3.14), younger age, male sex (1.17), smoking (1.24) and underweight (1.18). Diagnosed hypertension (0.61) and diabetes (0.38) were the strongest correlates of having been screened. Higher prudent (0.91 per item) and risky (0.98 per item) dietary scores were modestly associated with having been screened.

Conclusion: Two in three Indonesian adults have never had cholesterol checked. Screening follows a steep educational gradient and occurs mainly after another cardiometabolic condition is diagnosed, a substantial gap in noncommunicable disease surveillance and prevention.

Keywords: cholesterol screening; dyslipidemia; dietary risk; noncommunicable disease; Indonesia

1. Introduction

Dyslipidemia, which comprises elevated total and low-density lipoprotein (LDL) cholesterol, low high-density lipoprotein (HDL) cholesterol and elevated triglycerides, is among the most consequential modifiable causes of cardiovascular disease, the leading cause of death worldwide. Elevated LDL cholesterol ranks among the leading risk factors for disability-adjusted life years lost globally [1], and in the INTERHEART study abnormal lipid profiles were the largest attributable risk factor for acute myocardial infarction across 52 countries, ahead of hypertension, smoking and diabetes [2]. Over four decades the epicentre of non-optimal cholesterol has moved from high-income Western countries towards parts of Asia [3], and in rapidly urbanising low- and middle-income countries (LMICs) the rise in coronary heart disease has outpaced the capacity of health systems to detect and manage it [4]. Reducing this burden depends on an awareness-to-treatment cascade in which individuals are screened, diagnosed, treated and brought to control. In the Asia-Pacific region the cascade fractures early: awareness, treatment and control of dyslipidemia lag well behind those of hypertension and diabetes [5, 6]. Indonesia illustrates this pattern. National biomarker data put the prevalence of high total cholesterol at 30–48%, depending on survey round, subgroup and threshold [5, 6], and a comparison of Aceh province with the United States found adverse HDL and non-HDL cholesterol profiles in Indonesian adults despite their younger age and

more favourable body mass index [7]. Yet Indonesia's principal national health survey contains no dedicated self-reported dyslipidemia diagnosis question of the kind fielded for hypertension and diabetes, so population-level dyslipidemia awareness has no direct national indicator. Cardiovascular disease is already the leading cause of death in Indonesia, and control of cardiometabolic risk factors remains well short of national and global targets [8]. In the absence of a diagnosis indicator, self-reported screening behaviour is an indirect but policy-relevant measure: people who are never screened cannot be diagnosed, counselled or treated, whatever their true lipid status. Large awareness–treatment–control gaps for hypertension and diabetes are well documented in LMICs [9–11], as is the poor preparedness of primary care for routine risk-factor detection [12, 13]. Because cholesterol testing requires laboratory infrastructure that is less widely available than a blood pressure cuff, we hypothesised that the screening gap for cholesterol exceeds that for hypertension. Andersen's behavioural model of health services use, which distinguishes predisposing, enabling and need factors [14], led us to expect that never having been screened would be associated with lower education, younger age, rural residence and the absence of a diagnosed cardiometabolic condition, which brings people into regular contact with primary care.

Diet is the best documented modifiable determinant of population lipid levels and cardiometabolic mortality [15, 16], and the nutrition transition has brought energy-dense, processed foods to urbanising populations, including Indonesia [17, 18]. Whether adults with riskier diets are more or less likely to be screened has not, to our knowledge, been examined with nationally representative Indonesian data. Three gaps motivate this study: there is no national estimate of cholesterol screening in Indonesia; cholesterol screening has not been compared with blood pressure and glucose screening in the same national sample; and the relation between dietary risk and screening behaviour, as opposed to biomarker outcomes, is unexplored. We therefore used the 2023 Indonesian Health Survey to estimate the prevalence of never having had cholesterol checked among Indonesian adults and to examine its association with dietary risk patterns and with sociodemographic, anthropometric and comorbidity correlates.

2. Materials and methods

2.1. Study design and data source

This is a secondary, cross-sectional analysis of the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia, SKI 2023), a nationally representative household survey conducted by the Health Development Policy Agency of the Indonesian Ministry of Health in all 38 provinces [19]. The survey used multistage, stratified cluster sampling: census blocks were selected as primary sampling units within each province, stratified by urban and rural classification, followed by systematic household selection. The individual questionnaire (SKI23.IND) included a routine health-check module (Block G, item G43) on how often respondents checked blood pressure, body weight, height, waist circumference, total cholesterol and blood glucose and, for women, cervical and breast cancer screening. We used the de-identified provincial extract files, which contain the final analysis weight and the primary sampling unit and stratum identifiers needed for design-based estimation. Trained enumerators, supervised by team leaders and subject to independent quality-control re-checking, administered the questionnaire face to face. The dietary items used to build the dietary scores (Block G, items G23 and G31) preceded the health-check module, so any general tendency towards more or less complete self-disclosure would be expected to act in the same direction on both sets of items, a point relevant to Section 4.3.

2.2. Study population

We included all respondents aged 15 years or older who were interviewed directly rather than by proxy, consistent with the age threshold specified for Block G items. This yielded an analytic sample of 616,111 adults. Of the 34,500 census blocks selected, 34,065 (98.74%) were visited; the remaining 435 (1.26%), in seven provinces (North Sumatra, West Sumatra, North Kalimantan, West Papua, Papua, Central Papua and Highland Papua), could not be surveyed because of security conditions and bad weather. Questionnaires were completed in 315,646 households (91.49% of the 345,000 target), and 877,531 of the 1,082,958 household members visited (81.0%) were interviewed and measured at all ages [19].

2.3. Measures

2.3.1. Cholesterol screening behaviour

Item G43e asked how often respondents checked their total cholesterol, in health or illness; response options were at least monthly, quarterly, six-monthly or yearly, more than yearly, or never. The primary outcome, never having been screened for cholesterol, was a response of "never". For comparison we built identically defined indicators for blood pressure (item G43a), blood glucose (item G43f) and waist circumference (item G43d). This outcome measures engagement with risk ascertainment, not dyslipidemia status: a respondent classified as never screened may or may not have dyslipidemia. We adopted it deliberately because inferring lipid status from reported diet would require assumptions that are not supported at the individual level [20].

2.3.2. Dietary risk patterns

A ten-item risky dietary score (0–10) was constructed from item G23 as the number of the following ten food categories consumed three or more times per week: sweet foods, sweet beverages, salty foods, fatty or fried foods, grilled or charred foods, preserved or processed meats, flavour-enhancing seasonings, soft drinks, energy drinks and instant noodles. A four-item prudent dietary score (0–4) was constructed from item G31 as the number of the following food groups consumed three or more times per week: legumes and nuts, vegetables, fruit, and fish or seafood. Both items asked about usual consumption in the previous month on a six-point scale (more than once a day to never); consumption three or more times per week corresponded to the three most frequent categories.

2.3.3. Anthropometric, clinical and sociodemographic covariates

Body mass index (BMI) was calculated from measured weight and height (Block J) and categorised with Asian cut-offs (underweight <18.5, normal 18.5–22.9, overweight at risk 23.0–24.9, obese class I 25.0–29.9, obese class II or higher ≥30.0 kg/m²). Central obesity was defined as a waist circumference ≥90 cm in men and ≥80 cm in women, in line with the International Diabetes Federation Asian cut-offs. Physician-diagnosed hypertension (item B18) and diabetes (item B07a) were self-reported, as was current or former smoking, defined as having ever smoked daily or non-daily (item G11). Waist circumference was not measured in pregnant women. Sex, age group (six categories from 15–24 to ≥65 years), urban or rural residence, highest completed education (six categories) and macro-region (Sumatra, Java, Bali and Nusa Tenggara, Kalimantan, Sulawesi, Maluku, Papua) were taken from the household roster.

2.4. Statistical analysis

All analyses used the final sampling weight, normalised to a sample mean of 1. We described the weighted composition of the sample, the weighted distribution of screening frequency across the four health checks and the weighted prevalence of never having been screened for cholesterol by subgroup. We implemented a survey-weighted logistic regression by iteratively reweighted least squares in Python, with the weight entering the estimating equations and cluster-robust (sandwich) standard errors at the primary sampling unit level, with a small-sample degrees-of-freedom correction. A single multivariable model regressed never having been screened for cholesterol on the risky and prudent dietary scores, age, sex, residence, education, macro-region, BMI category, central obesity, smoking status, diagnosed hypertension and diagnosed diabetes simultaneously. Adjusted odds ratios (aORs) are reported with 95% confidence intervals (CIs) and Wald p values; $p<0.05$ (two-sided) was considered statistically significant. A descriptive dose–response analysis examined the prevalence of never having been screened across the full range of the risky dietary score. The outcome and all interview-based covariates had no missing values among the 616,111 respondents, and the 'not applicable' response code did not occur. Weight, height or waist circumference were missing or implausible for some respondents (waist circumference <40 cm was treated as implausible), so BMI was available for 608,215 adults (98.7%) and waist circumference for 584,730 (94.9%); the multivariable model used complete cases (n=581,366; 94.4%), and no imputation or sensitivity analysis was performed. Analyses used Python 3.12 (pandas, NumPy, SciPy, Matplotlib). This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for cross-sectional studies [21]; the completed checklist is provided as Online Resource 1.

2.5. Ethical considerations

The SKI 2023 protocol was approved by the Health Research Ethics Committee (Komite Etik Penelitian Kesehatan; reference LB.02.01/I/KE/L/287/2023, 10 May 2023), and all participants gave informed consent (Persetujuan Setelah Penjelasan) before interview; consent was documented on a written form providing for the respondent's signature and, where applicable, a guardian's signature. The present analysis used anonymised secondary data, involved no new data collection or contact with participants, and was conducted in accordance with the principles of the Declaration of Helsinki; no additional ethical approval or consent was required.

2.6. Use of large language models

The authors used Claude (Anthropic), a large language model (LLM), to assist with formatting this manuscript to the journal's style, compiling and verifying the reference list, and editing the Methods, Results reporting and Discussion sections for clarity and consistency. The LLM is not listed as an author. The authors reviewed and verified all AI-assisted content for accuracy and integrity and take full responsibility for the content of the manuscript.

3. Results

3.1. Sample characteristics

The 616,111 adults were 50.1% male and 49.9% female, 58.7% urban and 41.3% rural, with 19.3% aged 15–24 years and 8.8% aged 65 years or older (Table 1). Java accounted for the largest regional share (56.9%), followed

by Sumatra (21.2%). Education was concentrated at senior secondary (33.3%) and primary level (25.1%). Anthropometric risk was substantial: 35.6% of adults were obese (class I or II or higher), 18.1% were overweight at risk and 39.6% had central obesity. One third (33.3%) reported current or former smoking. Diagnosed hypertension (8.0%) and diabetes (2.2%) were far less frequent than this anthropometric profile would imply, consistent with substantial underdiagnosis. The weighted mean risky dietary score was 4.06 of 10 and the mean prudent dietary score was 2.41 of 4, indicating that most adults combined risk-conferring and protective dietary patterns rather than falling into clearly "healthy" or "unhealthy" groups.

Table 1 Weighted sociodemographic, anthropometric and dietary characteristics of Indonesian adults aged ≥15 years (2023 Indonesian Health Survey, n=616,111)

Characteristic	n	Weighted %[a]
Sex		
Male	279,699	50.1
Female	336,412	49.9
Age group (years)		
15–24	84,112	19.3
25–34	113,664	21.6
35–44	146,933	20.3
45–54	129,562	17.5
55–64	88,190	12.5
≥65	53,650	8.8
Residence		
Urban	330,554	58.7
Rural	285,557	41.3
Macro-region		
Java	174,136	56.9
Sumatra	191,895	21.2
Sulawesi	93,013	7.3
Bali and Nusa Tenggara	51,853	5.4
Kalimantan	58,019	6.1
Papua	25,887	2.0
Maluku	21,308	1.1
Education		
No or incomplete primary	72,163	10.4
Primary	152,881	25.1
Junior secondary	124,627	21.3
Senior secondary	194,766	33.3
Diploma	29,878	3.8
University	41,796	6.1
Body mass index category (Asian cut-offs)[b]		
Underweight	46,781	8.8
Normal	213,093	36.2
Overweight (at risk)	118,249	18.1
Obese class I	169,374	26.0
Obese class II or higher	60,718	9.6
Clinical and behavioural factors		
Central obesity[c]	251,377	39.6

Characteristic	n	Weighted %[a]
Current or former smoker	176,569	33.3
Diagnosed hypertension	51,918	8.0
Diagnosed diabetes	14,454	2.2
Dietary scores (mean)		
Risky dietary score (0–10)	616,111	4.06
Prudent dietary score (0–4)	616,111	2.41

[a] Percentages are weighted using the final survey weight of the 2023 Indonesian Health Survey and represent national estimates among directly interviewed adults. For the dietary scores, weighted means are shown

[b] Percentages are of all 616,111 respondents; BMI was missing or implausible for 7,896 (1.3%)

[c] Percentage among the 584,730 adults with a valid waist circumference measurement

3.2. Screening uptake across four routine health checks

Blood pressure screening had the most favourable uptake: 35.1% of adults had never had their blood pressure checked (Fig. 1, Table 2). In contrast, 66.6% had never had their cholesterol checked and 65.9% had never had their blood glucose checked, almost twice the blood pressure proportion, while waist circumference had the lowest uptake (73.5% never measured). Among the minority who had ever checked cholesterol, screening was infrequent: only 4.5% checked at least monthly and 6.0% at least quarterly, and most checked no more often than yearly. The frequency distribution for blood glucose was almost identical to that for cholesterol, so the gap spans both biochemical indicators. These weighted estimates were close to the official SKI 2023 tabulations for all respondents aged ≥15 years, in which 35.8%, 67.2%, 66.4% and 73.9% had never had blood pressure, total cholesterol, blood glucose and waist circumference checked, respectively [19].

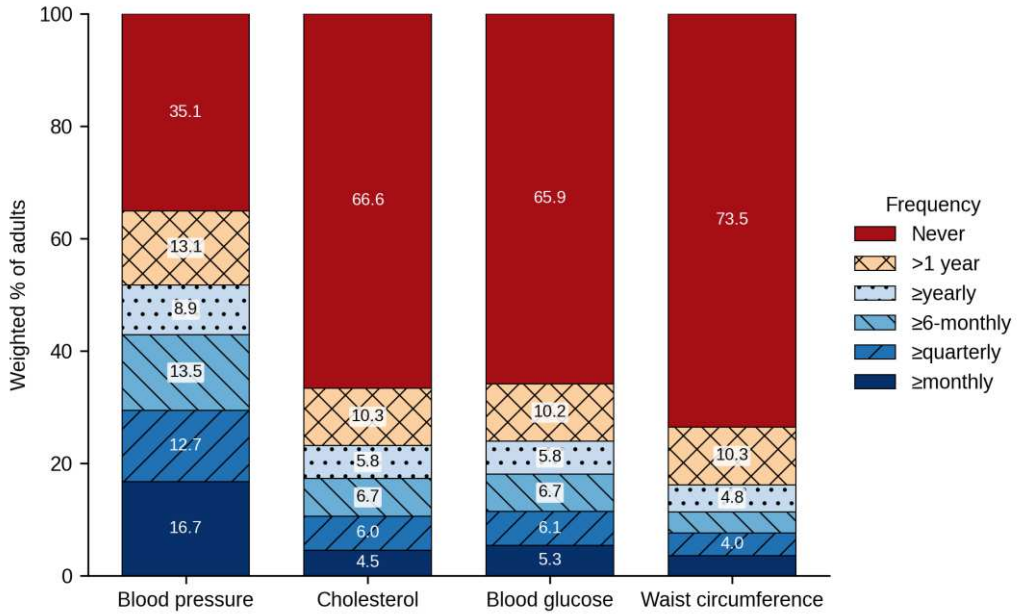


Fig. 1 Self-reported screening frequency for four routine health checks among Indonesian adults aged ≥15 years (2023 Indonesian Health Survey, n=616,111). Stacked bars show the weighted percentage of adults by reported frequency of each check, from at least monthly to never. Numbers within segments are weighted percentages

Table 2 Weighted prevalence of never having been screened across four routine health checks, and for cholesterol by subgroup (2023 Indonesian Health Survey)

Health check / subgroup	Weighted %[a]
Panel A. Never screened, by type of health check	
Blood pressure	35.1
Cholesterol	66.6
Blood glucose	65.9
Waist circumference	73.5
Panel B. Never screened for cholesterol, by subgroup	
Male	70.6
Female	62.6
Age 15–24 years	83.8
Age 25–34 years	70.2
Age 35–44 years	65.3
Age 45–54 years	59.8
Age 55–64 years	54.3
Age ≥65 years	54.0
Urban	65.0
Rural	68.9
No or incomplete primary education	67.4
Primary education	67.6
Junior secondary education	72.7
Senior secondary education	67.0
Diploma	47.6
University	49.6
Underweight	77.4
Normal weight	71.8
Overweight (at risk)	64.5
Obese class I	60.7
Obese class II or higher	57.8
Java	69.6
Sumatra	64.7
Sulawesi	59.7
Bali and Nusa Tenggara	72.3
Kalimantan	49.3
Papua	64.3
Maluku	66.8

[a] All estimates are weighted using the final survey weight. “Never screened” indicates no self-reported history of the health check

3.3. Never having been screened for cholesterol, by subgroup

The prevalence of never having been screened varied widely (Table 2). The steepest gradient was educational, from 47.6% among adults with diploma-level education and 49.6% among university graduates to 72.7% among those with junior secondary education and 67–68% among those with primary or no or incomplete primary schooling (Fig. 2). Prevalence fell with age, from 83.8% at 15–24 years to 54.0% at 65 years or older, and was higher in men (70.6%) than in women (62.6%). Regional prevalence ranged from 49.3% in Kalimantan to 72.3%

in Bali and Nusa Tenggara. In simple cross-tabulation prevalence declined with increasing BMI, from 77.4% among underweight adults to 57.8% among those with obesity class II or higher.

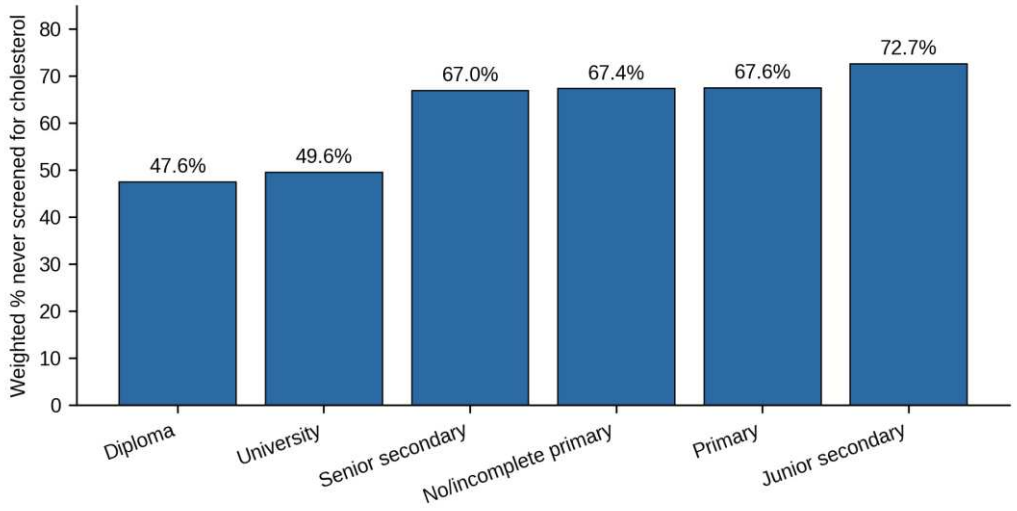


Fig. 2 Never having checked cholesterol by educational attainment, Indonesian adults aged ≥15 years (2023 Indonesian Health Survey). Bars show the weighted percentage of adults in each educational category who had never had cholesterol checked

3.4. Risky dietary score and screening: a non-monotonic descriptive relation

The crude relation between the risky dietary score and never having been screened was an inverted U rather than a linear gradient (Fig. 3): prevalence rose from 55.9% among adults reporting no risky items to a peak of 69.0% at five items, then fell to 52.1% in the small subgroup reporting all ten. This suggests confounding, plausibly by age and comorbidity, which the multivariable model was designed to address.

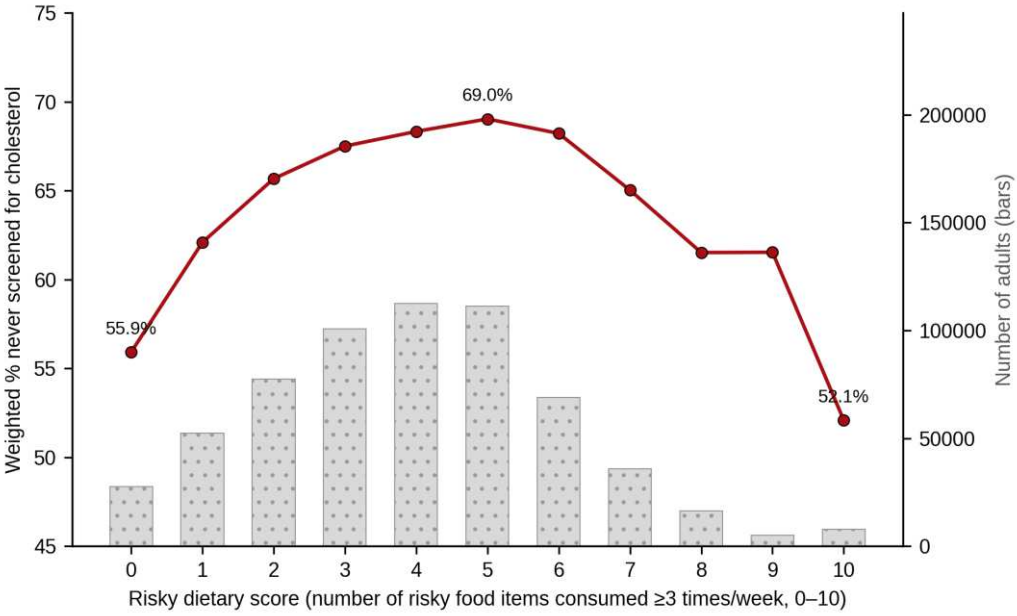


Fig. 3 Prevalence of never having been screened for cholesterol by risky dietary score (0–10), showing a non-monotonic descriptive relation (2023 Indonesian Health Survey). The line shows the weighted prevalence (left axis) and the bars show the number of adults at each score (right axis)

3.5. Adjusted correlates of never having been screened

In the multivariable model (Fig. 4; n=581,366 with complete data), both dietary scores showed small inverse associations with never having been screened: aOR 0.98 per risky item (95% CI 0.97–0.99, p<0.001) and 0.91 per prudent item (95% CI 0.90–0.93, p<0.001). Relative to diploma-level education, the odds of never having been screened were higher for no or incomplete primary education (aOR 2.95, 95% CI 2.78–3.14), primary education (2.79, 2.64–2.94), junior secondary education (2.37, 2.25–2.50) and senior secondary education (1.84, 1.75–1.93; all p<0.001), with no significant difference for university education (1.05, p=0.095). Male sex (aOR 1.17, 95% CI 1.13–1.20) and current or former smoking (1.24, 1.20–1.28) were associated with higher odds, as was younger age (aOR 0.97 per year of age) and underweight (1.18, 1.14–1.23, relative to normal weight). Overweight (aOR 0.84), obesity class I (0.80), obesity class II or higher (0.75) and central obesity (0.89, 95% CI 0.86–0.91) were associated with lower odds. The strongest correlates were diagnosed comorbidities: diagnosed hypertension (aOR 0.61, 95% CI 0.59–0.63) and diagnosed diabetes (0.38, 0.35–0.40) were associated with 39% and 62% lower odds, respectively, the latter being the largest association in the model. Urban residence was associated with modestly lower odds (aOR 0.94, 95% CI 0.91–0.98, p=0.002). Regional differences persisted after adjustment: relative to Bali and Nusa Tenggara, odds were markedly lower in Kalimantan (aOR 0.35, 95% CI 0.32–0.38) and significantly lower in Sulawesi, Sumatra, Papua and Maluku, whereas Java did not differ significantly.

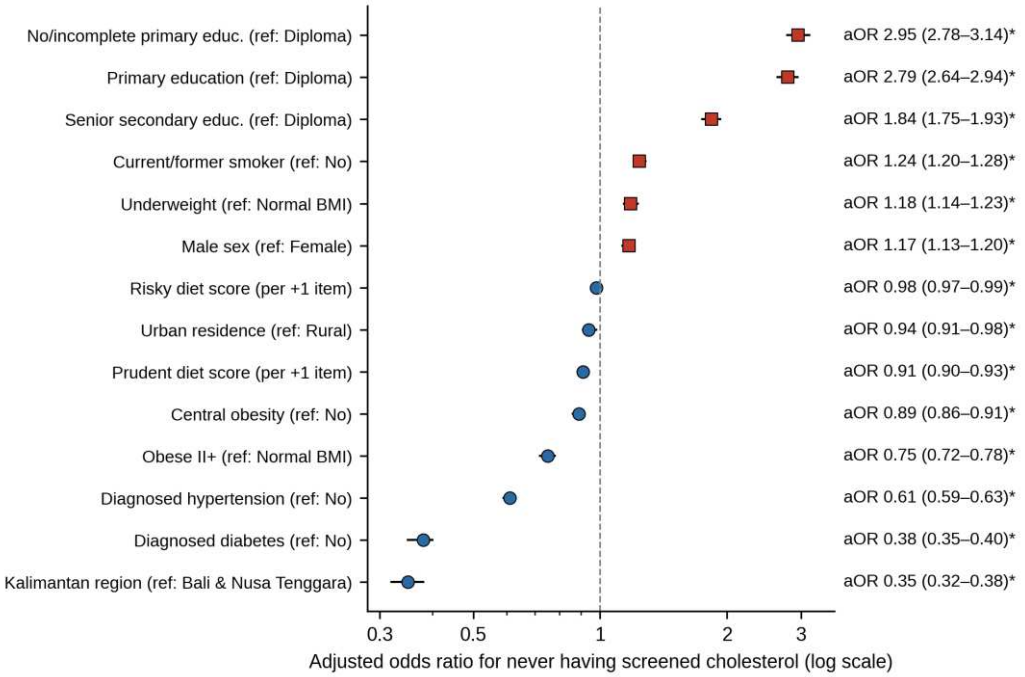


Fig. 4 Forest plot of adjusted odds ratios (95% confidence intervals) for selected correlates of never having been screened for cholesterol, from a survey-weighted logistic regression model with cluster-robust standard errors at the primary sampling unit level (2023 Indonesian Health Survey). Points show adjusted odds ratios, horizontal lines show 95% confidence intervals on a logarithmic scale, and the vertical dashed line marks an odds ratio of 1. Squares denote odds ratios above 1 and circles denote odds ratios below 1. Reference categories are given in parentheses. Asterisks denote p<0.05

4. Discussion

4.1. Principal findings

In this national analysis of 616,111 adults, two in three had never had their cholesterol checked, almost twice the proportion for blood pressure and nearly identical to that for blood glucose. This provides, with nationally representative data for the first time, direct evidence of the cascade-of-care asymmetry between hypertension and dyslipidemia that had previously been inferred from regional epidemiology [5, 6]. It may reflect global policy, in which lipid management is typically positioned as a consequence of cardiovascular risk stratification rather than an independent screening target in resource-constrained primary care [22]; even among adults eligible for statins in LMICs, only about one in ten use them for primary prevention [23]. Second, the gap followed a steep educational gradient, paralleling the social patterning of screening and care for other noncommunicable diseases in LMICs [9, 10]. Third, the strongest correlates of having been screened were diagnosed diabetes and hypertension, so cholesterol screening in Indonesia functions mainly as a reactive extension of chronic disease management rather than as population-wide primary prevention. Most adults without a diagnosed cardiometabolic condition, including an unknown but plausibly large number with undetected dyslipidemia, therefore remain outside the reach of the current informal screening pathway. For context, in the SKI 2023 biomedical sub-sample (weighted n=28,756) 27.8% of participants had borderline and 11.7% had high total cholesterol, and the proportion with high cholesterol rose from 2.8% at 15–24 years to 21.2% at 55–64 years [19].

4.2. Education gradient and reactive screening

Adults with no or incomplete primary education had nearly three times the odds of never having been screened compared with diploma-educated adults. This is consistent with evidence that education shapes use of preventive services through health literacy, financial capacity to pay for laboratory tests, occupational flexibility and exposure to health promotion [24–26], and with Andersen's model, in which education is an enabling resource shaping realised access independently of clinical need [14]. The strength of the diabetes and hypertension associations points to a second, more readily actionable mechanism: patients already in contact with the health system for one cardiometabolic condition are opportunistically screened for another. The corollary is that adults without such a diagnosis, including many with undiagnosed hypertension or diabetes [9, 10], are unlikely ever to be screened, a missed opportunity for primary rather than secondary prevention. The same logic explains why overweight and obese adults were more likely than normal-weight adults to have been screened: body habitus is visible to clinicians and prompts opportunistic risk-factor testing.

4.3. Interpreting the dietary score associations

Both dietary scores were modestly and inversely associated with never having been screened, so adults reporting more frequent consumption of nominally risky foods were, after adjustment, slightly more likely to have been screened. We do not interpret this as evidence that risky diets promote screening. Higher counts on both scores more plausibly reflect a shared construct of general engagement with food and the health system, linked to urbanisation, income and food-environment exposure and to the clustering of health-related behaviours in higher socioeconomic groups [17]; the dietary items preceded the screening items in the same interview (Section 2.1), so reporting consistency may contribute. The inverted-U crude relation (Fig. 3) likewise indicates confounding by age and socioeconomic position. The prudent score's association was nearly twice as large as the risky score's,

which suggests that any genuine link between diet and screening is more plausibly carried by health-conscious choices (legumes, vegetables, fruit, fish) than by avoidance of risky foods. This hypothesis needs dedicated behavioural research.

4.4. Body mass index, smoking and sex

The higher odds of never having been screened among smokers are the more concerning finding: this group combines elevated behavioural cardiovascular risk with reduced engagement in risk-factor screening, the combination most likely to produce undetected, accumulating risk. Women were more likely than men to have been screened, although Indonesian women in Aceh were reported to have less favourable lipid profiles relative to men than expected from the United States comparison [7]. If that finding generalises nationally, higher female uptake may not fully offset women's relative lipid disadvantage, while lower male uptake compounds men's own risk. This tension cannot be resolved with screening data alone and calls for biomarker-linked analysis.

4.5. Strengths and limitations

Strengths are a very large, nationally representative sample covering all 38 provinces, direct within-sample comparison of four routine health checks, and survey-weighted, cluster-robust multivariable regression. Several limitations apply. First, the outcome is a proxy for engagement with risk ascertainment, not a measure of dyslipidemia diagnosis, treatment or control; we cannot tell what proportion of ever-screened adults were informed of an abnormal result or link screening to biomarker status. Second, self-reported screening is subject to recall error and social desirability bias in either direction. Third, the cross-sectional design precludes causal inference, and the dietary associations in particular are descriptive and hypothesis-generating. Fourth, the dietary scores are unweighted sums of binary frequency indicators; they discard information on portion size and food quality (for example the fat composition of fried foods), were drawn from existing questionnaire content rather than designed for lipid risk, and have not been validated against dietary biomarkers or nutrient intake. Fifth, household income and health insurance status, key enabling resources in Andersen's model, were not available in the extract and were at most partly proxied by education; their inclusion would probably sharpen the socioeconomic gradient. Sixth, the multivariable model was restricted to complete cases, excluding 5.6% of respondents with missing or implausible anthropometric measurements, mostly waist circumference. Finally, our custom regression implementation follows standard sandwich-estimator methodology but has not been benchmarked against established survey-statistics software, and independent replication is advisable before the point estimates are used for policy.

4.6. Policy and programmatic implications

Three implications follow. First, future survey rounds should include a dedicated dyslipidemia diagnosis and treatment-status question parallel to the hypertension and diabetes modules, allowing direct rather than proxy-based tracking of the dyslipidemia care cascade. Second, the reactive pattern of current practice supports a move towards proactive, age- and risk-stratified lipid screening within routine contact at Puskesmas (community health centres), consistent with guideline recommendations for risk-based screening from early adulthood [27] and with the World Health Organization (WHO) package of essential noncommunicable disease interventions [22]. Community-based programmes with non-physician delivery have improved hypertension detection and control at modest cost in South Asia [28], and modelling suggests that broader diabetes screening in India is a cost-effective

use of constrained resources [29], both supporting the feasibility of expanded lipid screening. Because low-cost treatments such as statins and polypill strategies are available once raised lipids are identified [30], identification is the limiting step. Third, the educational gradient argues for outreach targeted at lower-education groups, for whom point-of-care lipid testing may be a cost-effective way to lessen laboratory requirements in decentralised primary care. Integrated risk-factor protocols that flag smokers for opportunistic cholesterol testing at any primary care contact [31] could further narrow the gap in this high-risk, underserved subgroup.

5. Conclusion

Two in three Indonesian adults have never had their cholesterol checked, a gap roughly twice that for blood pressure. It follows a steep educational gradient and arises mainly as a reactive extension of hypertension or diabetes care, so groups at elevated risk (less educated, male, smoking, and without another diagnosed cardiometabolic condition) are least likely to be reached. Uptake was lowest among younger adults; although the prevalence of high cholesterol in the national biomedical sub-sample was highest in mid- to late adulthood, the very low uptake in early adulthood leaves little opportunity for early detection and risk-factor modification. A dedicated dyslipidemia indicator in national surveys and proactive, risk-stratified lipid screening in routine primary care are warranted.

Statements and Declarations

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Competing interests The authors have no relevant financial or non-financial interests to disclose.

Ethics approval The SKI 2023 protocol was approved by the Health Research Ethics Committee (Komite Etik Penelitian Kesehatan; reference LB.02.01/I/KE/L/287/2023, 10 May 2023). The present study is a secondary analysis of anonymised data, involved no new data collection or contact with participants, and was conducted in accordance with the principles of the Declaration of Helsinki; no additional ethical approval was required.

Consent to participate All participants gave informed consent (Persetujuan Setelah Penjelasan) before being interviewed in SKI 2023; consent was documented on a written form providing for the respondent's signature and, where applicable, a guardian's signature.

Consent to publish Not applicable. The analysis used anonymised data and the manuscript contains no information that could identify individual participants.

Data availability The data that support the findings of this study are available from the Health Policy Development Agency, Ministry of Health of the Republic of Indonesia (SKI 2023). Restrictions apply to the availability of these data: they are owned by the Ministry of Health and are not publicly available because of data governance restrictions. Access may be requested from the Ministry of Health subject to its data-sharing procedures.

Supplementary information Online Resource 1 (ESM_1.pdf): completed STROBE checklist for cross-sectional studies, indicating where each item is reported in the manuscript.

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