

Addressing the Obesity-Diabetes Continuum in Cambodia: A Critical Review of Health Policy, Regulation, and Care Delivery System Readiness

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ABSTRACT

Cambodia is undergoing a rapid epidemiological transition marked by an escalating continuum of obesity and type 2 diabetes mellitus (T2DM). This study evaluates Cambodia's health policy responsiveness, regulatory frameworks, and care delivery system readiness to address this shifting chronic disease burden. Synthesizing national data from the Cambodia Demographic and Health Survey 2021–22 and the STEPS Survey 2023 alongside national strategic frameworks, this review provides a critical macro-level policy-linked analysis, filling a vital literature gap by bridging clinical epidemiology with health systems governance. Findings confirm a severe metabolic burden, with 31.7% of adult women overweight/obese, 15.2% experiencing abdominal adiposity, and T2DM prevalence reaching 6.4%. Crucially, 50% of T2DM cases remain undiagnosed, a systemic failure rooted in primary care unreadiness, diagnostic stockouts of HbA1c and lipid panels, and historical prioritization of acute infectious management. Socioeconomic disparities compound this risk, as individuals with no formal education exhibit the highest T2DM prevalence (11.2%). On the regulatory front, current fiscal policies like sugar-sweetened beverage taxation require aggressive strengthening, while financial frameworks like the Health Equity Fund lack preventative screening mandates. This review contributes a novel, multi-level evaluation framework that transitions Cambodia's public health discourse from passive clinical reporting to active, systemic healthcare reorientation. Ultimately, mitigating this metabolic crisis demands restructuring primary care into chronic care models, expanding financial protection for preventative services, and enforcing multi-sectoral dietary regulations.

Keywords: Health Policy, Regulatory Frameworks, Care Delivery Readiness, Obesity-Diabetes Continuum, Primary Health Care, Cambodia



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1. INTRODUCTION

The global escalation of obesity and type 2 diabetes mellitus (T2DM) has evolved into a major public health challenge that places substantial pressure on healthcare systems, increases healthcare expenditures, and adversely affects population health worldwide (Ruze et al., 2023; Soares Andrade et al., 2023; Sung & Lee, 2025). Global projections indicate that the number of adults living with diabetes will increase from approximately 537 million in 2021 to 783 million by 2045, reinforcing diabetes as one of the most significant contributors to premature mortality and reduced life expectancy worldwide (Sun et al., 2022). Within this paradigm, excess adiposity remains the most important modifiable risk factor for type 2 diabetes mellitus (T2DM), with approximately 80–90% of individuals with T2DM being

overweight or obese (Grant et al., 2021; Wondmkun, 2020). This metabolic challenge is disproportionately concentrated in Southeast Asia, a region that witnessed a 59.5% increase in age-standardized T2DM prevalence between 1990 and 2019, with Cambodia and Indonesia exhibiting the most precipitous escalations (Nugrahani et al., 2025). Crucially, the regional trajectory cannot be decoupled from unique anthropometric vulnerabilities, specifically the South Asian phenotype, wherein populations develop profound insulin resistance and accelerated pancreatic beta-cell attrition at deceptively lower body mass index (BMI) thresholds compared to Western cohorts (Cao et al., 2025; Mohan, 2025). This thin-fat phenotype is marked by greater visceral and ectopic fat accumulation despite relatively low BMI, often accompanied by lower skeletal muscle mass, underscoring the limitations of BMI-based screening and the need for ethnicity-specific risk assessment (Iliodromiti et al., 2023; Williams & Periasamy, 2020).

Cambodia provides an important setting to examine the interaction between rapid nutrition transition and health system adaptation, as economic development and accelerating urbanization are reshaping traditional dietary patterns, physical activity, and the burden of non-communicable diseases (Chham et al., 2023; Popkin & Ng, 2022). Agrarian diets traditionally characterized by high fiber and micronutrient intake are increasingly being replaced by energy-dense processed foods and sugar-sweetened beverages (SSBs). This dietary transition has been accelerated by commercial determinants of health that promote the widespread availability and marketing of unhealthy commercial food products (Brown et al., 2024; Hinnouho et al., 2023). Consequently, although communicable diseases historically dominated Cambodia's epidemiological profile, the country is now undergoing a rapid epidemiological transition in which non-communicable diseases (NCDs) have become the leading causes of morbidity and mortality, placing increasing pressure on the national health system (Comey et al., 2025; Sorn et al., 2026). Recent nationally representative evidence indicates that the prevalence of diabetes among Cambodian adults has reached 6.4%, accompanied by a 4.4% prevalence of impaired fasting glucose (Haruyama et al., 2025). Furthermore, the high burden of undiagnosed diabetes reflects important gaps in early case detection and indicates the need to strengthen primary healthcare systems through expanded screening, timely diagnosis, and preventive interventions (Chhim, Ku, et al., 2026; Teufel et al., 2026). This hidden metabolic burden coincides with a continuing rise in overweight and obesity among Cambodian adults, particularly women, together with increasing levels of central adiposity, reflecting an expanding national burden of cardiometabolic risk (Um & An, 2024).

Although the epidemiological burden of diabetes and other cardiometabolic diseases in Cambodia has become increasingly well documented, important research gaps remain. Existing studies have predominantly focused on estimating disease prevalence and identifying individual-level risk factors, whereas considerably less attention has been devoted to evaluating health-system governance, integrated service delivery, and the institutional capacity required to respond effectively to the growing burden of chronic diseases (Chham et al., 2023; Te et al., 2024). A notable gap remains between clinical and epidemiological research and health systems research. Existing studies predominantly emphasize disease prevalence, individual risk factors, and clinical management, whereas considerably less attention has been given to how governance, financing, regulatory policies, and primary healthcare delivery can be aligned with the unique biological characteristics and lower BMI-related metabolic risk observed in Asian populations (Khanna et al., 2026; Sekar et al., 2023; Te, Ma, et al., 2023). Specifically, previous studies have paid limited attention to systemic bottlenecks affecting early diabetes detection within Cambodia's primary healthcare system, the real-world effectiveness of sugar-sweetened beverage taxation in counteracting commercial market expansion, and the capacity of financial protection mechanisms such as the Health Equity Fund to support sustained diabetes screening, diagnosis, and long-term chronic disease management (Chhim, Ku, et al., 2026; Feldhaus et al., 2021; Haruyama et al., 2025; Ministry of Health Cambodia & World Health Organization, 2025). Without filling this literature-to-policy gap, strategic health planning will remain structurally reactive, leaving primary care infrastructure ill-equipped to manage an escalating chronic disease paradigm.

To address this critical deficit, this study transitions the public health discourse from passive epidemiological recording to an active, system-readiness evaluation. The primary objective of this review is to critically evaluate Cambodia's health policy responsiveness, regulatory frameworks, and primary care delivery system readiness in mitigating the escalating obesity-diabetes continuum. To achieve this overarching goal, this analysis systematically evaluates current fiscal and regulatory measures against commercial dietary environments, isolates structural and infrastructural vulnerabilities within primary health centers that impede diagnostic coverage, assesses how metabolic risks cluster across sociodemographic strata to determine the equity of social protection mechanisms, and synthesizes the underlying pathophysiological mechanisms of the Asian metabolic phenotype to establish a robust, biologically grounded mandate for health system reorientation. Ultimately, this inquiry synthesizes an evidence-based structural roadmap to transition Cambodia's healthcare delivery from an acute-focused model to a proactive, long-term chronic care paradigm, thereby accelerating the attainment of Sustainable Development Goal 3.4.

2. METHOD

2.1. Review Design

To bridge clinical epidemiology with health systems governance, this study adopted a policy-oriented systematic narrative synthesis. This approach enables the structured integration of heterogeneous evidence including epidemiological findings, health system evidence, and policy documents to generate context-specific insights that can inform health policy and guideline development (Carmona et al., 2021; Fadlallah et al., 2019). This design ensures a transparent, iterative, and reproducible approach to identifying literature, selecting relevant policy data, and charting institutional themes. This structural rigor safeguards the study against selection bias while enabling a critical evaluation of healthcare delivery readiness and regulatory responsiveness across the obesity-diabetes continuum.

2.2. Data Sources and Search Strategy

The evidence base for this critical synthesis was harvested from two distinct operational pillars, capturing both empirical epidemiological parameters and structural policy mandates in Cambodia. The first pillar encompasses nationally representative health surveillance datasets, including the Cambodia Demographic and Health Survey (CDHS) 2011-12, which contains anthropometric and clinical infrastructure data from 19,717 women aged 15 to 49 years and 16,597 men aged 15 to 54 years (National Institute of Statistics (NIS) et al., 2023). Biochemical, metabolic, and behavioral data were retrieved from the Cambodia STEPS Survey 2023, a standardized approach to non-communicable disease risk factor surveillance involving 3,660 participants aged 18 to 69 years (Ministry of Health Cambodia & World Health Organization, 2025). The second pillar consists of national strategic documents, primarily the Cambodia National Strategic Plan for the Prevention and Control of Noncommunicable Diseases 2022-2030 (Ministry of Health Cambodia, 2022).

To supplement these primary sources, a systematic literature search was executed across PubMed, Scopus, and Web of Science databases for peer-reviewed studies published between January 2019 and January 2026. The primary search strategy utilized targeted Boolean expressions, specifically: ("Cambodia" OR "Southeast Asia") AND ("obesity" OR "overweight" OR "abdominal obesity") AND ("diabetes" OR "insulin resistance" OR "metabolic syndrome") AND ("epidemiology" OR "prevalence" OR "risk factors"). A secondary search string targeted mechanistic pathways using the terms: ("insulin resistance" OR "adipose tissue inflammation") AND ("obesity" OR "free fatty acids") AND ("type 2 diabetes" OR "beta cell dysfunction"). Literature inclusion was restricted to peer-reviewed empirical studies, systematic reviews, and clinical guidelines published in the English language. Document exclusion criteria comprised isolated case reports, clinical trials lagging baseline epidemiological data, and conference abstracts without accessible full-text manuscripts.

2.3. Data Extraction and Synthesis Framework

Data extraction was organized using a standardized matrix capturing specific quantitative and qualitative variables across multiple clinical and structural domains. Quantitative extractions focused on prevalence rates paired with 95% confidence intervals where available, including markers for overweight, obesity, abdominal adiposity, pre-diabetes, diagnosed T2DM, undiagnosed T2DM fractions, hypertension, and dyslipidemia. Sociodemographic and behavioral determinants, such as age, geographic residence, formal education levels, wealth quintiles, sugar-sweetened beverage intake, and daily alcohol patterns, were tabulated to examine risk factor clustering. Qualitative extractions focused on documented molecular pathophysiological mechanisms of the Asian metabolic phenotype and structural healthcare challenges.

To ensure analytical rigor and mitigate single-investigator bias, a dual-reviewer consensus protocol was implemented during the screening and extraction phases. The collected evidence was subsequently synthesized using a thematic framework analysis, clustered into four macro-level evaluative streams, namely: (1) the epidemiological profile and socio-demographic distribution of the obesity-diabetes burden in Cambodia; (2) the biological and pathophysiological justification of the thin-fat phenotype, serving as the clinical mandate for system intervention; (3) the institutional readiness of the primary care delivery system, pinpointing infrastructure, diagnostic equipment, and workforce bottlenecks; and (4) the evaluation of multi-sectoral fiscal and regulatory policy interventions targeting commercial determinants of health. Quantitative parameters were analyzed contextually relative to system capacities, while qualitative data from policy blueprints were narratively synthesized to identify structural gaps between policy intent and care delivery implementation.

To facilitate policy interpretation, interventions identified through the narrative synthesis were qualitatively prioritized across four implementation domains: feasibility, cost-effectiveness, anticipated population impact, and implementation priority. This prioritization was informed by the WHO Best Buys for Noncommunicable Diseases, the Cambodia National Strategic Plan for the Prevention and Control of Noncommunicable Diseases 2022–2030, and the overall strength and consistency of evidence identified

in the included literature. Feasibility was assessed based on implementation complexity, administrative capacity, stakeholder acceptability, and policy readiness. Cost-effectiveness reflected evidence from published economic evaluations and WHO recommendations, whereas population impact represented the anticipated reach and potential contribution of each intervention to reducing obesity and type 2 diabetes at the population level. Implementation priority was determined through an integrative appraisal of these domains while considering the Cambodian health system context.

3. RESULTS

3.1. Epidemiological Profile and Socio-Demographic Distribution

The synthesis of Cambodia's national surveillance data reveals a substantial baseline burden of excess adiposity, characterized by marked demographic and geographic disparities. Analysis of the Cambodia Demographic and Health Survey (CDHS) 2021–22 shows that 23.9% of women aged 15–49 years are overweight and 7.8% are obese, resulting in a combined prevalence of 31.7%. This increasing burden of excess body weight coexists with a 12.0% prevalence of underweight, reflecting Cambodia's persistent double burden of malnutrition. Anthropometric indicators also vary considerably across geographic settings, with the combined prevalence of overweight and obesity reaching 42.1% among urban women compared with 28.1% among their rural counterparts. At the subnational level, Phnom Penh records the highest obesity prevalence at 15.2% (National Institute of Statistics (NIS) et al., 2023). Beyond conventional body mass index (BMI) indicators, central adiposity constitutes an additional metabolic concern. Findings from the Cambodia STEPS Survey 2023 indicate that abdominal obesity affects 15.2% of adults aged 18–69 years, with a pronounced sex disparity, reaching 18.8% among women compared with 11.7% among men (Ministry of Health Cambodia & World Health Organization, 2025).

The rapid rise in anthropometric risk factors is accompanied by a substantial burden of abnormal glucose regulation, characterized by a high proportion of previously undiagnosed cases within the community. Evidence from the Cambodia STEPS Survey 2023 indicates that the prevalence of type 2 diabetes mellitus (T2DM) among adults aged 18–69 years is 6.4%, while an additional 4.4% exhibit impaired fasting glucose. Notably, approximately half of all diabetes cases were previously undiagnosed and were identified through fasting plasma glucose measurements conducted during the national survey. Together, these findings demonstrate a considerable burden of abnormal glycaemic status among Cambodian adults, with prevalence increasing markedly with age, from less than 2% among adults aged 18–29 years to 14.8% among those aged 60–69 years (Haruyama et al., 2025). To provide an integrated overview of Cambodia's cardiometabolic burden, Table 1 summarizes key sociodemographic characteristics and cardiometabolic risk indicators in the general adult population alongside corresponding estimates among individuals with diabetes. Drawing on nationally representative surveillance datasets, this comparison highlights the epidemiological contrasts that underpin the subsequent assessment of health system preparedness and policy responses.

Table 1

Comparative Summary of National Surveillance Indicators in the General Adult Population and Adults with Diabetes in Cambodia

Risk Factor	General Population (%)	Adults with Diabetes (%)
Age ≥ 40 years	42.1	87.3
Overweight/Obesity (BMI ≥ 25 kg/m ²)	31.7*	58.2
Abdominal Obesity†	15.2	28.4
Hypertension (BP ≥ 140/90 mmHg)	28.2	48.7
Elevated Triglycerides (≥ 150 mg/dL)	18.5	35.8
Low HDL-C (cholesterol)‡	24.1	31.5
Daily Alcohol Consumption	12.8	19.4
Daily Sugar-Sweetened Beverage (SSB) Consumption	24.6	32.1
Physical Inactivity§	38.7	45.2
Urban Residence	28.3	35.7
No Formal Education	18.4	32.6
Poorest Wealth Quintile	20.0	26.3

Note. Population estimates were synthesized from the Cambodia Demographic and Health Survey (CDHS) 2021–22 (National Institute of Statistics (NIS) et al., 2023) and the Cambodia STEPS Survey (Ministry of Health Cambodia & World Health Organization, 2025). Diabetes-specific estimates were derived from Haruyama et al. (2025) based on the Cambodia STEPS Survey 2023. Consequently, values presented in this table represent a comparative synthesis of nationally representative surveillance data rather than estimates generated from a single analytical dataset.

Table 1 provides a comparative epidemiological overview of major cardiometabolic and sociodemographic characteristics among the general adult population and adults with diabetes in

Cambodia. Across nearly all indicators, adults with diabetes exhibit a consistently higher prevalence of metabolic, behavioral, and socioeconomic risk factors than the general population. For example, the prevalence of hypertension increases from 28.2% in the general population to 48.7% among adults with diabetes, while elevated triglycerides nearly double from 18.5% to 35.8%. Similarly, daily sugar-sweetened beverage consumption is more common among adults with diabetes (32.1%) than in the general population (24.6%), suggesting the coexistence of unfavorable dietary behaviors with established metabolic disease (Haruyama et al., 2025; Ministry of Health Cambodia & World Health Organization, 2025). The comparative profile also highlights pronounced socioeconomic disparities. Adults with diabetes are more likely to have no formal education (32.6% vs. 18.4%), belong to the poorest wealth quintile (26.3% vs. 20.0%), and reside in urban areas (35.7% vs. 28.3%) than the general population. Collectively, these findings suggest that diabetes in Cambodia is embedded within a broader constellation of interconnected cardiometabolic, behavioral, and social vulnerabilities rather than occurring as an isolated clinical condition. To further characterize these epidemiological patterns, Table 2 presents the distribution of major cardiometabolic risk factors across key sociodemographic characteristics, including age group, sex, place of residence, and educational attainment.

Table 2

Distribution of Major Cardiometabolic Risk Factors Across Sociodemographic Characteristics in Cambodia

Characteristic	Abdominal Obesity (%)	Elevated Blood Pressure (%)	Elevated Glucose (%)	Elevated Triglycerides (%)	Low HDL-C (%)
Age Group					
18–29	5.2	8.4	2.1	12.3	18.5
30–39	11.8	16.7	4.8	16.9	22.1
40–49	19.2	28.5	7.3	21.4	26.8
50–59	24.7	38.9	10.6	24.1	29.4
60–69	28.3	52.4	14.8	20.5	31.2
Sex					
Male	11.7	30.5	6.8	22.1	19.2
Female	18.8	26.1	6.0	15.2	28.7
Residence					
Urban	22.4	32.8	8.2	21.5	26.1
Rural	12.7	26.4	5.6	16.8	23.2
Education					
No formal education	19.8	35.2	11.2	19.4	27.8
Primary	15.3	28.7	6.8	18.6	24.5
Secondary or higher	13.1	22.4	4.1	16.2	21.3

As shown in Table 2, substantial sociodemographic disparities exist across the major cardiometabolic risk factors. The prevalence of elevated fasting glucose increases markedly among individuals with lower educational attainment, reaching 11.2% among those with no formal education compared with 4.1% among those with secondary or higher education. Geographic differences are also evident, with urban residents exhibiting higher prevalences of elevated blood pressure (32.8% vs. 26.4%) and abdominal obesity (22.4% vs. 12.7%) than rural residents (Haruyama et al., 2025; Ministry of Health Cambodia & World Health Organization, 2025). Age-related gradients are similarly pronounced. The prevalence of elevated fasting glucose rises progressively from 2.1% among adults aged 18–29 years to 14.8% among those aged 60–69 years, accompanied by marked increases in abdominal obesity, elevated blood pressure, and low HDL cholesterol. Sex-specific differences are also apparent, with women exhibiting substantially higher prevalences of abdominal obesity and low HDL cholesterol, whereas men demonstrate higher prevalences of elevated blood pressure and triglycerides. Collectively, these findings indicate that cardiometabolic risk in Cambodia is unequally distributed across the population, disproportionately affecting older adults, urban residents, and individuals with lower educational attainment. This epidemiological heterogeneity highlights the importance of targeted prevention, early detection, and risk-based screening strategies within Cambodia's national NCD control programme.

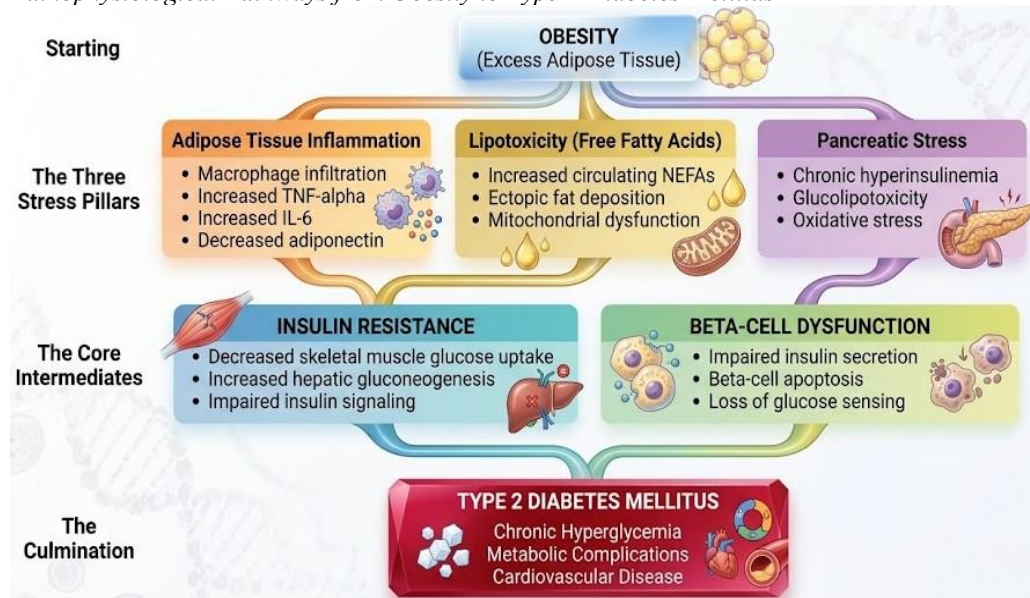
3.2. Pathophysiological Justification of the Asian Phenotype

The biological distinctiveness of the target population provides a critical scientific mandate for health system restructuring, as conventional healthcare models fail to account for unique metabolic vulnerabilities. Obesity triggers a chronic, low-grade inflammatory state within adipose tissue

characterized by significant macrophage infiltration and elevated secretion of pro-inflammatory cytokines, including tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6), and monocyte chemoattractant protein-1 (MCP-1), which directly disrupt downstream insulin signaling pathways (Chavakis et al., 2023; Kawai et al., 2021; Yao et al., 2022). This inflammatory cascade is further amplified by the activation of the NLRP3 inflammasome, which drives peripheral insulin resistance, while the concurrent downregulation of adiponectin deprives the body of an essential anti-inflammatory, insulin-sensitizing adipokine (Lei et al., 2023; Lu et al., 2023; Ortega et al., 2023). Parallel to this cytokine imbalance, accelerated adipose tissue expansion promotes excessive lipolysis, causing a sustained release of non-esterified free fatty acids into the systemic circulation (Grabner et al., 2021; White, 2023). These chronically elevated free fatty acids compete with glucose for cellular oxidation in skeletal muscle through the glucose–fatty acid (Randle) cycle while simultaneously activating intracellular inflammatory signaling pathways, including protein kinase C (PKC) and nuclear factor- κ B (NF- κ B), leading to severe endoplasmic reticulum stress and mitochondrial dysfunction (Lemmer et al., 2021; Römer et al., 2021). The structural interactions of these cascading cellular abnormalities, tracing the progress from cellular adiposity to organ stress, are mapped out systematically in Figure 1.

Figure 1

Pathophysiological Pathways from Obesity to Type 2 Diabetes Mellitus



The systemic pathways detailed in Figure 1 culminate in extensive ectopic fat deposition, wherein excess triglycerides accumulate outside traditional adipose depots and are deposited within non-adipose organs such as the liver, skeletal muscle, heart, and pancreas, thereby contributing to metabolic dysfunction and insulin resistance (Buitinga et al., 2023; Kozawa & Shimomura, 2021; White, 2023). This cellular misplacement leads to hepatic steatosis, which markedly increases gluconeogenesis and promotes atherogenic dyslipidemia. This metabolic vulnerability is particularly pronounced in Asian populations, who tend to accumulate visceral adiposity at lower body mass index thresholds than Western populations (Chan et al., 2023; Misra et al., 2025; Scoditti et al., 2024; Yanai et al., 2023). Although pancreatic β -cells initially compensate for peripheral insulin resistance by increasing insulin secretion to maintain normoglycemia, chronic exposure to hyperinsulinemia, glucotoxicity, lipotoxicity, oxidative stress, and endoplasmic reticulum stress progressively impairs β -cell function, leading to β -cell exhaustion and apoptosis (Oberhauser & Maechler, 2021; Römer et al., 2021; Vilas-Boas et al., 2021). Compared with European populations, Asian populations exhibit a lower intrinsic β -cell functional reserve and a reduced capacity to compensate for insulin resistance, resulting in a more rapid decline in β -cell function. Consequently, type 2 diabetes frequently develops at younger ages and lower body mass index levels, consistent with the Asian "thin-fat" phenotype (Chan et al., 2023; Khin et al., 2023; Sayeed Kassem et al., 2023). This biological reality highlights the inadequacy of reactive health system models and demands a shift toward proactive primary care screening protocols tailored to early pancreatic preservation.

3.3. Institutional Readiness of the Care Delivery System

The institutional evaluation of Cambodia's primary healthcare system reveals persistent structural weaknesses in preparedness for the growing burden of non-communicable diseases (Annear et al., 2019). Critical constraints include inadequate surveillance systems, limited diagnostic capacity, shortages of essential point-of-care equipment, insufficient availability of diabetes medicines, workforce shortages,

and weak referral coordination across different levels of care (Ministry of Health Cambodia & World Health Organization, 2025). Consequently, the primary healthcare framework remains configured for reactive, acute infectious care, leaving it ill-equipped to execute the systematic clinical screening needed to intercept the obesity-diabetes continuum at an early stage.

These widespread primary care capacity bottlenecks are further reinforced by structural gaps within Cambodia's social protection and health financing mechanisms. The Health Equity Fund (HEF), which constitutes the country's principal financial protection scheme for poor households and currently covers approximately 27.4% of the population, has no dedicated provisions or budgetary mechanisms for routine diabetes or cardiometabolic screening. Consequently, the scheme remains largely treatment-oriented rather than prevention-oriented, limiting opportunities for early detection of non-communicable diseases among vulnerable populations (Haruyama et al., 2025). Expanding the Health Equity Fund benefit package to include proactive diabetes and other non-communicable disease screening could improve early diagnosis, increase equitable access to essential services, and strengthen financial risk protection for vulnerable populations in Cambodia (Chham et al., 2023; Feldhaus et al., 2021; Jithitikulchai et al., 2021).

3.4. Multi-Sectoral Fiscal and Regulatory Policy Landscape

The structural evaluation of Cambodia's response to the commercial determinants of health highlights a critical need to align current environmental regulations with international public health standards. To counter the rapid dietary shifts caused by unregulated market expansion, national strategies have increasingly emphasized population-level fiscal policies, such as sugar-sweetened beverage taxation, to reduce unhealthy beverage consumption while generating fiscal resources that can support public health programmes (Andreyeva et al., 2022; Hattersley & Mandeville, 2023). However, the real-world effectiveness of these fiscal measures depends heavily on tax design and the magnitude of the resulting price increase. Contemporary evidence indicates that health taxes are most effective in reducing purchases and consumption when they generate substantial retail price increases, with price increases of approximately 20% or more consistently recommended to achieve meaningful changes in consumer behaviour (Alvarado et al., 2023; Andreyeva et al., 2022; Hammaker et al., 2022). Evaluating these fiscal instruments alongside broader health system interventions requires a systematic assessment of their administrative viability, financial efficiency, and overall population reach. The prioritized operational landscape of these structural interventions, categorized by implementation urgency and socioeconomic parameters, is detailed in Table 3.

Table 3

Prioritization of Public Health Interventions for Obesity and Type 2 Diabetes Prevention in Cambodia Based on Feasibility, Cost-Effectiveness, and Population Impact

Intervention	Feasibility	Cost-Effectiveness	Population Impact	Implementation Priority
Population-Level Primary Prevention				
Sugar-sweetened beverage taxation	High	High	Very High	Immediate
Front-of-package nutrition labeling	High	Moderate	High	Short-term (1–2 years)
Restrictions on food marketing to children	Moderate	Moderate	High	Short-term (1–2 years)
Healthy food subsidies	Moderate	Moderate	High	Medium-term (2–3 years)
Built environment modifications	Moderate	Moderate	Moderate	Medium-term (2–3 years)
Workplace wellness programs	High	Moderate	Moderate	Short-term (1–2 years)
High-Risk Screening & Secondary Prevention				
Community-based diabetes screening	High	High	High	Immediate
Diabetes prevention programs (lifestyle)	Moderate	Very High	High	Immediate
Metformin for high-risk pre-diabetes	High	High	Moderate	Short-term (1–2 years)
CHW-led health education	High	High	High	Immediate
Mobile health screening units	Moderate	Moderate	Moderate	Medium-term (2–3 years)

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Tertiary Prevention & Diabetes Management				
Strengthening primary care diabetes services	Moderate	High	High	Immediate
Diabetes self-management education	High	High	High	Immediate
Ensuring essential medication availability	High	Very High	Very High	Immediate
Complications screening programs	Moderate	High	Moderate	Short-term (1–2 years)
mHealth for medication adherence	High	Moderate	Moderate	Short-term (1–2 years)

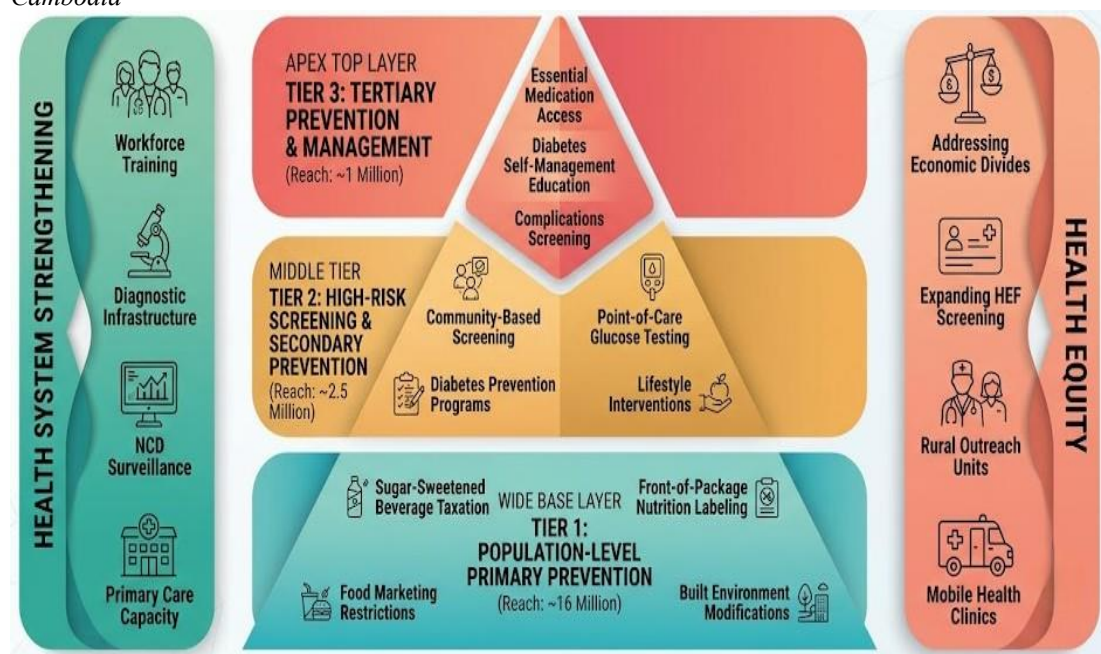
Note. Rankings were derived using the policy prioritization framework described in Section 2.3. The assessment was informed by the WHO Best Buys for Noncommunicable Diseases, the Cambodia National Strategic Plan for the Prevention and Control of Noncommunicable Diseases 2022–2030 (Ministry of Health Cambodia, 2022) and the evidence synthesized from the included studies.

Table 3 summarizes the prioritization of evidence-informed public health interventions for obesity and type 2 diabetes prevention in Cambodia. Population-level interventions generally demonstrate the greatest potential for broad and sustainable health gains, although implementation feasibility varies according to administrative capacity and policy readiness. Among these, sugar-sweetened beverage taxation represents the highest-priority strategy because of its strong evidence base, high cost-effectiveness, and potential to reduce population-level sugar consumption while generating fiscal resources for health programmes. Community-based diabetes screening, community health worker-led education, strengthening primary care diabetes services, diabetes self-management education, and ensuring the availability of essential medicines also emerge as immediate priorities owing to their anticipated impact on early detection, continuity of care, and long-term disease control.

Beyond fiscal measures, strengthening food environment regulations represents a critical policy strategy to protect vulnerable populations. Mandatory front-of-package nutrition labeling and restrictions on the marketing of unhealthy foods and beverages to children are recognized as effective regulatory approaches to reduce the appeal of ultra-processed foods, promote healthier consumer choices, and encourage product reformulation by the food industry (Ganderats-Fuentes & Morgan, 2023; Roberto et al., 2021; Taillie et al., 2020). These population-level strategies should be complemented by targeted healthy food subsidies that reduce financial barriers to purchasing fruits, vegetables, and whole grains, particularly among low-income households, thereby improving access to healthier dietary choices (Huangfu et al., 2024). To systematically conceptualize how these upstream regulatory environments interlock with clinical screening and patient care, it is necessary to visualize the entire healthcare matrix as a unified system. This multi-layered prevention model, charting population coverage against institutional interventions, is structurally illustrated in Figure 2.

Figure 2

Public Health Intervention Framework for Obesity and Diabetes Prevention: A Multi-Level Strategy for Cambodia



The institutional architecture illustrated in Figure 2 operates through three distinct, interdependent structural tiers that systematically scale down from macro-population interventions to individualized clinical care. Within this pyramid design, the first tier encompasses population-level primary prevention targeting the entire national population of approximately 16 million people, leveraging macro-level regulatory levers such as sugar-sweetened beverage taxation, front-of-package nutrition labeling, restrictive food marketing to children, healthy food subsidies, and active built environment modifications. Moving down the prevention continuum, the second tier addresses high-risk screening and secondary prevention, specifically targeting an estimated 2.5 million high-risk adults through proactive community-based screening, point-of-care glucose testing, structured lifestyle adjustments, and targeted metformin protocols for pre-diabetic individuals. Finally, the third tier governs tertiary prevention and chronic disease management, focusing its clinical resources on the established diabetic cohort of approximately 1 million individuals to optimize self-management education, enhance medication adherence support, integrate mobile health technologies, and implement systematic screening for microvascular and macrovascular complications.

The comprehensive architecture integrated into Figure 2 establishes an interdependent health system model where population-wide interventions serve as the structural foundation to lower baseline metabolic risks across the entire demographic spectrum. This broad base directly limits the volume of individuals transitioning into Tier 2 high-risk categories, where targeted community-based screening and intensive lifestyle interventions are deployed. The clinical value of these secondary prevention strategies is well established, as contemporary systematic reviews demonstrate that structured lifestyle interventions emphasizing modest weight loss, dietary improvement, and regular physical activity significantly reduce the risk of progression from prediabetes to type 2 diabetes while improving glycaemic control and other cardiometabolic outcomes (Bahari et al., 2023; Sagastume et al., 2022; Villegas et al., 2022).

For individuals who progress to Tier 3, the institutional focus shifts toward preventing microvascular and macrovascular complications through proactive primary care delivery, reliable access to essential pharmaceuticals like metformin and insulin, and structured multi-disciplinary coordination (Misra et al., 2025). This tiered continuum is anchored by parallel, vertical pillars of health system strengthening to build long-term infrastructural capacity, and health equity frameworks to actively remove socioeconomic and geographic barriers (Ministry of Health Cambodia, 2022). Ultimately, this integrated regulatory and care delivery framework provides a balanced, evidence-based strategy to reorient Cambodia's health infrastructure from a reactive treatment design into a highly proactive, multi-sectoral chronic care paradigm.

4. DISCUSSION

4.1. Systemic Interpretation of the Obesity-Diabetes Continuum

The obesity–diabetes continuum observed in Cambodia reflects the convergence of structural food environment determinants and underlying metabolic susceptibility. The rapid expansion of ultra-processed foods and sugar-sweetened beverages represents a failure of food system governance rather than merely the aggregation of individual lifestyle choices. In the absence of comprehensive fiscal and regulatory measures, including effective sugar-sweetened beverage taxation and mandatory front-of-package nutrition labeling, commercial determinants of health have progressively reshaped dietary behaviors toward greater consumption of energy-dense processed foods (Lane et al., 2024; Roberto et al., 2021). This nutritional transition is mirrored by the high prevalence of abdominal obesity documented in national surveillance data (Ministry of Health Cambodia & World Health Organization, 2025).

At the biological level, excess visceral adiposity promotes chronic low-grade inflammation, increased free fatty acid flux, and progressive insulin resistance through multiple interconnected metabolic pathways (Chait & den Hartigh, 2020). These mechanisms are likely to exert even greater consequences within Southeast Asian populations, whose lower insulin secretory reserve and greater susceptibility to β -cell dysfunction accelerate progression from insulin resistance to overt type 2 diabetes (Cao et al., 2025; Mohan, 2025). Persistent exposure to obesogenic environments therefore amplifies glucolipotoxic stress on pancreatic β -cells, contributing to progressive β -cell dysfunction and eventual failure (Wysham & Shubbrook, 2020). Collectively, these findings suggest that weaknesses in food environment governance are translated through biological mechanisms into the escalating burden of obesity and type 2 diabetes in Cambodia.

Similarly, the finding that approximately half of all type 2 diabetes cases in Cambodia remain previously undiagnosed reflects a substantial structural gap in the country's primary healthcare system rather than a temporary operational shortcoming (Haruyama et al., 2025). This diagnostic deficit suggests that primary healthcare services remain insufficiently equipped to provide systematic population-based screening and early detection for chronic metabolic diseases. Historically, Cambodia's health system has been largely oriented toward the control of communicable diseases and maternal-child health, with comparatively limited emphasis on long-term management of non-communicable diseases (Ministry of

Health Cambodia, 2022). Although this model has achieved important gains in infectious disease control, it is less effective for conditions such as obesity and type 2 diabetes, which develop gradually and often remain asymptomatic for prolonged periods before clinical diagnosis (Ministry of Health Cambodia & World Health Organization, 2025).

The absence of routine risk-based screening, limited availability of diagnostic equipment at primary healthcare facilities, and insufficient integration of preventive services within existing financing mechanisms further constrain early case detection (Haruyama et al., 2025). Consequently, many individuals are diagnosed only after significant metabolic deterioration has occurred, reducing opportunities for timely lifestyle intervention and increasing the risk of cardiovascular and microvascular complications. These findings underscore the importance of strengthening primary healthcare capacity, expanding community-based screening programmes, and integrating preventive diabetes services into routine primary care delivery.

4.2. Cross-National Comparative Analysis with Regional Evidence

Placing Cambodia's cardiometabolic profile within the broader Asia-Pacific context suggests that its current diabetes burden remains lower than that reported in several highly urbanized economies, including Malaysia and Singapore, while broadly comparable with neighbouring countries such as Vietnam and Thailand. Nevertheless, regional evidence indicates that many Southeast Asian countries are experiencing a similar epidemiological transition characterized by rising obesity, population ageing, and increasing prevalence of type 2 diabetes, suggesting that Cambodia may follow a comparable trajectory in the absence of effective preventive policies (OECD/WHO, 2022; Sun et al., 2022). Comparative analyses of long-term diabetes trends across Southeast Asia indicate that Cambodia has experienced one of the fastest increases in the burden of type 2 diabetes over the past three decades, closely paralleling the trajectory observed in Indonesia. Regional projections further suggest that, without sustained population-level prevention and health system strengthening, this epidemiological transition is likely to accelerate in the coming decades, placing substantial pressure on health systems and public health resources (Nugrahani et al., 2025; Zhu et al., 2026). When viewed within the broader Southeast Asian context, Cambodia's finding that approximately half of all adults with type 2 diabetes remain previously undiagnosed is consistent with regional evidence indicating that a substantial proportion of diabetes cases across low- and middle-income countries remain unidentified because of limited access to routine screening, diagnostic services, and continuous primary healthcare management. Similar challenges have been documented throughout South and Southeast Asia, where delayed diagnosis remains a major barrier to effective diabetes prevention and control (Sun et al., 2022). The persistence of high levels of undiagnosed diabetes across developing Asian countries suggests that this problem extends beyond individual health behaviors and reflects broader health system constraints. Limited availability of opportunistic screening, inadequate integration of diabetes risk assessment into primary healthcare services, shortages of diagnostic resources, and fragmented long-term follow-up collectively hinder the early detection of dysglycaemia. These systemic challenges reduce opportunities for timely lifestyle intervention and substantially increase the risk of preventable cardiovascular and microvascular complications.

To mitigate these growing cardiometabolic burdens, comparing Cambodia's fiscal policies with those implemented in neighboring countries provides valuable lessons for policy optimization. Although Cambodia has initiated an excise tax framework targeting sugar-sweetened beverages (SSBs), its current fiscal structure remains relatively modest and may be insufficient to substantially influence consumer purchasing behavior or reshape commercial determinants of health. By contrast, Thailand has implemented a tiered excise tax based on sugar concentration, which has stimulated widespread product reformulation and reductions in the sugar content of commercially available beverages (Phonsuk et al., 2021). Evidence from recent systematic reviews further demonstrates that well-designed fiscal policies, particularly those that substantially increase retail prices, are effective in reducing purchases of sugar-sweetened beverages while generating important public health benefits (Andreyeva et al., 2022). These fiscal measures are most effective when implemented alongside complementary regulatory interventions, including mandatory front-of-package nutrition labeling and restrictions on the marketing of unhealthy foods, which together encourage healthier consumer choices and incentivize industry reformulation (Roberto et al., 2021). Consequently, Cambodia has an important opportunity to strengthen its current regulatory framework by transforming sugar taxation from a predominantly revenue-generating instrument into a comprehensive public health policy integrated with broader food environment regulations (Cao et al., 2025).

4.3. The Urbanization of Poverty and Health Inequities

The socioeconomic gradients identified in Cambodia's dysglycaemia profile reveal a distinct epidemiological transition, challenging the traditional assumption that type 2 diabetes mellitus (T2DM) is primarily a disease of affluence in low- and middle-income countries. National surveillance data indicate that adults with no formal education exhibit the highest prevalence of elevated fasting glucose (11.2%),

compared with only 4.1% among those who completed secondary education or higher (Haruyama et al., 2025). This educational gradient suggests that metabolic risk has become increasingly concentrated among socioeconomically disadvantaged populations. One plausible explanation is the persistent disparity in health literacy, which influences individuals' ability to access, understand, and apply nutrition and health information when making dietary and lifestyle decisions. Lower health literacy has consistently been associated with poorer diabetes prevention behaviours, reduced engagement with preventive healthcare services, and less favourable glycaemic outcomes (Nutbeam & Lloyd, 2021). These educational disadvantages are further amplified by the rapid expansion of commercial food environments. Populations with limited socioeconomic resources are disproportionately exposed to inexpensive ultra-processed foods and sugar-sweetened beverages, while simultaneously facing greater financial constraints in accessing healthier diets. Recent evidence indicates that consumption of ultra-processed foods is consistently associated with increased risks of obesity, type 2 diabetes, and other chronic metabolic disorders, particularly among socially disadvantaged populations (Lane et al., 2024). Educational disadvantage also intersects with financial vulnerability, limiting access to preventive healthcare services, routine diabetes screening, and sustained lifestyle modification (Hill-Briggs et al., 2021). Consequently, the same population groups experiencing the greatest burden of dysglycaemia are often those with the least capacity to obtain early diagnosis and continuous chronic disease management. These findings illustrate how social determinants of health contribute to widening cardiometabolic inequalities and highlight the need for equity-oriented prevention strategies that integrate health literacy, food environment regulation, and accessible primary healthcare services.

This educational stratification is heavily magnified by the phenomenon of the urbanization of poverty across Cambodia's rapidly expanding metropolitan landscapes, particularly within the capital city of Phnom Penh. While urban centers drive macroeconomic expansion, they simultaneously construct severe metabolic traps for low-income, rural-to-urban migrant populations who settle in peripheral municipal zones. This geographic and economic cleavage is clearly reflected in national datasets, which document that Phnom Penh exhibits the highest localized obesity rate at 15.2%, while general urban residence features significantly higher rates of elevated blood pressure at 32.8%, elevated glucose at 8.2%, and abdominal adiposity at 22.4% compared to rural baselines (National Institute of Statistics (NIS) et al., 2023). In the densely populated informal settlements of Phnom Penh, the structural layout of the built environment forces a dependency on cheap, calorie-dense, and nutrient-poor processed commodities because fresh, high-fiber, traditional foods are often economically out of reach for marginalized urban laborers. This systemic lack of access to healthy food options, combined with a sharp reduction in active occupational transportation and a corresponding rise in sedentary informal labor, accelerates visceral fat accumulation and triggers the thin-fat phenotype within these vulnerable groups (Misra et al., 2025; Mohan, 2025). Because national health financing mechanisms like the Health Equity Fund do not yet mandate or finance proactive non-communicable disease screening for urban poor households, the urbanization of poverty in Phnom Penh effectively transforms economic deprivation into an unaddressed, biologically embedded cardiometabolic crisis (Haruyama et al., 2025).

4.4. Methodological Strengths and Institutional Limitations

The analytical framework of this critical review possesses distinct methodological strengths that enhance its overall epidemiological robustness and policy relevance. A primary asset lies in its systemic integration of large-scale, high-quality national surveillance data, specifically leveraging the Cambodia Demographic and Health Survey which encompasses 36,314 participants alongside the Cambodia STEPS Survey containing biochemical data from 3,660 individuals (Ministry of Health Cambodia & World Health Organization, 2025). By relying on these extensive, stratified, and nationally representative sample sizes rather than localized clinical cohorts, this study achieves an exceptionally high level of external validity. The use of nationally representative surveillance datasets substantially strengthens the external validity of the findings, allowing the observed patterns of cardiometabolic risk factor clustering, sociodemographic disparities, and undiagnosed diabetes to be interpreted as broadly representative of the Cambodian adult population. Consequently, these findings provide a robust empirical foundation for informing national planning, priority setting, and multi-sectoral strategies for non-communicable disease prevention and control (Haruyama et al., 2025). Furthermore, by integrating nationally representative epidemiological evidence with an appraisal of Cambodia's strategic NCD policies, this review moves beyond descriptive epidemiology to generate policy-relevant evidence for health system planning and governance (Sorn et al., 2026).

Conversely, several inherent methodological and institutional limitations must be acknowledged to contextualize these findings within the broader health policy landscape. First, the underlying survey instruments operate through a cross-sectional design, inherently limiting the ability to establish temporal trajectories or infer causal relationships between rapid urbanization, commercial food environments, and the progressive deterioration of pancreatic β -cell function over time (Asahara et al., 2022; Ganasegeran et al., 2025). Second, the clinical identification of type 2 diabetes within national datasets relies

predominantly on single-point fasting plasma glucose measurements rather than comprehensive, mass-scale glycated hemoglobin or oral glucose tolerance protocols, which increases the margin of measurement error and potentially underestimates the true boundaries of the national metabolic burden (Butler et al., 2021; Haruyama et al., 2025). Finally, Cambodia continues to face important gaps in longitudinal diabetes surveillance, as available national health information primarily relies on cross-sectional assessments rather than integrated nationwide registries capable of tracking the incidence and progression of diabetic microvascular complications (retinopathy, nephropathy, and neuropathy) and macrovascular cardiovascular outcomes over time (Chhim, Kowal, et al., 2026; Te, Chhim, et al., 2023). This longitudinal data gap severely constrains the capacity of health administrators to accurately model future secondary healthcare resource requirements, measure chronic disease survival rates, or evaluate the long-term cost-effectiveness of current public health interventions.

4.5. Strategic Policy Roadmap and Future Research Priorities

The formulation of a strategic policy roadmap requires immediate structural interventions to transform Cambodia's health system from an acute, reactive model into a proactive, integrated, and multisectoral framework. Primary healthcare should be reoriented toward an adapted Chronic Care Model that emphasizes longitudinal patient follow-up, structured self-management support, interdisciplinary team-based care, and strengthened clinical information systems rather than fragmented, episodic clinic visits (Dufour et al., 2023; Longhini et al., 2022). To operationalize this transformation, sustainable financing mechanisms are essential. One strategic approach is to integrate systematic non-communicable disease screening into Cambodia's Health Equity Fund, thereby expanding financial protection for community-based metabolic screening, particularly among socioeconomically vulnerable populations covered by the scheme (Haruyama et al., 2025). Complementing these health-system reforms, Cambodia should strengthen fiscal policies addressing the commercial determinants of health by replacing the current nominal sugar-sweetened beverage tax with a threshold-based excise tax capable of substantially increasing retail prices. Such fiscal measures have been shown to reduce population-level consumption of sugar-sweetened beverages, encourage product reformulation across the food and beverage industry, and generate sustainable government revenue that can be reinvested in strengthening primary healthcare, preventive services, and diagnostic infrastructure (Andreyeva et al., 2022; Forberger et al., 2022).

Alongside these structural reforms, strengthening Cambodia's long-term response to the obesity–diabetes continuum also requires a strategic expansion of its national research agenda. Priority should be given to prospective cohort studies capable of accurately estimating diabetes incidence, characterizing longitudinal metabolic trajectories, and identifying the key socioeconomic, environmental, and behavioral determinants underlying the progression from prediabetes to overt type 2 diabetes mellitus within the Cambodian population (Te et al., 2022; Te, Chhim, et al., 2023). Beyond strengthening epidemiological evidence, future health economics research should prioritize localized cost-effectiveness analyses comparing community-based point-of-care screening delivered by community health workers with targeted facility-based screening strategies to identify the most efficient approaches for resource allocation in low-resource settings (Anyasodor et al., 2022; Sharma et al., 2022). In parallel, biomedical research should investigate genetic susceptibility to type 2 diabetes among Southeast Asian populations and elucidate how genetic predisposition interacts with environmental and nutritional exposures across the life course to influence disease risk (Cao et al., 2025; Mohan, 2025). Collectively, these complementary lines of epidemiological, economic, and biomedical research would establish a robust, context-specific evidence base to support evidence-informed clinical practice, optimize resource allocation, and guide regulatory and public health policies aimed at reducing Cambodia's long-term cardiometabolic disease burden.

5. CONCLUSION

Cambodia stands at a critical juncture where a rapidly accelerating obesity–diabetes continuum poses a structural threat to the foundational capacity of its public health infrastructure. The critical synthesis of national surveillance data confirms that cardiometabolic risks are heavily entrenched within the population, as manifested by a 31.7% combined overweight and obesity prevalence among adult women, 15.2% general abdominal adiposity, and a type 2 diabetes mellitus prevalence of 6.4%. Crucially, the distinct biological vulnerability of the Asian thin-fat phenotype interfaces destructively with a commercial landscape where approximately 50% of all diabetic individuals remain completely undiagnosed, signaling a massive, invisible metabolic wave. Rather than presenting a uniform distribution, this burden exhibits a pronounced epidemiological inversion, clustering intensely within populations with no formal education and within informal urban settlements where rapid, unregulated commercial determinants of health have transformed metropolitan growth into a concentrated cardiometabolic crisis.

The extensive evaluation conducted throughout this study demonstrates that Cambodia's current healthcare delivery system and regulatory frameworks remain systematically unready to govern this shifting chronic disease landscape. Frontline primary care health centers continue to endure severe

diagnostic shortages, including frequent stockouts of glucometers, HbA1c testing kits, and lipid panels, reflecting an institutional path-dependency engineered for reactive, acute infectious interventions rather than longitudinal chronic care tracking. This primary care unreadiness is structurally reinforced by health financing architectures like the Health Equity Fund, which covers 27.4% of vulnerable households but completely excludes proactive, preventative screening mandates from its budgetary allocations. Furthermore, upstream fiscal defenses remain sub-optimal, as nominal sugar-sweetened beverage taxation rates fall well below the internationally recognized 20% retail price escalation threshold required to effectively reduce purchasing volumes and incentivize manufacturer product reformulation.

To address these fragmented dimensions, this review contributes a novel, multi-level evaluation framework that transitions Cambodia's public health discourse from passive clinical reporting to active, systemic health governance reorientation. Although this academic synthesis is bounded by the cross-sectional architecture and single-point fasting glucose parameters of existing national datasets, it successfully establishes the empirical and structural foundation required to guide future prospective cohorts, localized health economics cost-effectiveness analyses, and regional genetic mapping investigations. Averting the devastating consequences of an unchecked metabolic epidemic requires an immediate reorientation of frontline healthcare toward an adapted Chronic Care Model anchored by community health worker-led screening algorithms. This care delivery restructuring must be balanced by strict multi-sectoral food environment regulations and a sharpened fiscal sugar tax design. The operational window to implement these interventions is rapidly closing, and without decisive, multi-level policy integration, Cambodia risks transforming preventable governance deficits into an irreversible biological crisis, ultimately stalling national progress toward Sustainable Development Goal 3.4.

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