Diabetes Risk Factor Screening in the Adult Population Using the Findrisc Score and Oral Glucose Tolerance Test

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Abstract

The global rise in the prevalence of type 2 diabetes is heavily concentrated in urban centers, yet more than half of those affected remain completely undiagnosed. Non-invasive clinical risk assessment tools can indeed stratify population risk, but there remains a gap in operational validation regarding the Finnish Diabetes Risk Score (FINDRISC) when combined with biochemical verification in urban populations in Indonesia. This study evaluated the diagnostic accuracy of the FINDRISC questionnaire in identifying undiagnosed type 2 diabetes and dysglycemia, using the oral glucose tolerance test (OGTT) as the gold standard. The study was conducted in the community using a cross-sectional design with non-random, purposive sampling in six subdistricts to recruit 300 adults aged 30–75 years. The 8-item FINDRISC questionnaire and anthropometric measurements were administered, followed by biochemical verification via OGTT and chi-square analysis. FINDRISC categorized 33.7% of participants as low-risk and 5.3% as high-risk, while the OGTT confirmed 18.0% had prediabetes and 30.0% had diabetes. Increased risk was significantly correlated with advanced age, high body mass index (BMI), central obesity, lack of physical activity, inadequate fruit and vegetable intake, treatment for hypertension, a history of hyperglycemia, and family predisposition ($p<0.005$). Among low-risk respondents, 68.3% had normal glucose levels, whereas 61.8% of high-risk individuals had glucose levels indicative of diabetes ($p<0.005$). The integration of the non-invasive FINDRISC triage tool prior to laboratory testing offers a resource-efficient sequential screening framework for urban primary health care. This strategy optimizes the allocation of institutional resources, detects subclinical dysglycemia early, and enables targeted preventive lifestyle interventions.

Keywords: Type 2 Diabetes, FINDRISC, Oral Glucose Tolerance Test, Mass Screening, Public Health Surveillance.

INTRODUCTION

According to the International Diabetes Federation, the global prevalence of diabetes mellitus has reached epidemic proportions, affecting an estimated 463 million adults, with projections climbing to 578 million by 2030 and 700 million by 2045 (Saeedi, 2019). Crucially, more than 50% of these individuals remain undiagnosed, living with covert dysglycaemia that silently drives macrovascular and microvascular damage long before clinical detection occurs (Franciosi, 2005). The global healthcare expenditure associated with managing this delayed diagnosis and its chronic sequelae is substantial, projected to consume USD 825 billion by 2030. Within the Southeast Asian region, Indonesia represents a critical epicentre of this crisis, ranking seventh globally with an adult diabetes prevalence that is expected to escalate to 16.6 million cases by 2045 (Saeedi, 2019). National data from the

Basic Health Research registry confirmed a sharp increase in adult diabetes prevalence from 6.9% to 8.5% over a five-year period, with a striking 69.6% of these individuals remaining entirely undiagnosed within their communities (Kementerian Kesehatan RI, 2018). Globally and regionally, the burden is heavily concentrated in urban centres; locally, North Sumatra ranks 13th among Indonesian provinces with an adult prevalence of 2.3%, whilst its capital, Medan City, exhibits a high disease concentration and a related mortality rate of 4.0%. This escalating localized trajectory highlights the importance of targeted public health surveillance to intercept hidden dysglycaemia before permanent physiological complications manifest (Banjarnahor, 2023).

Early identification of adults at increased risk of type 2 diabetes is a vital public health strategy, offering a critical window of opportunity for primary prevention and targeted lifestyle modifications that can alter the disease trajectory (Crandall, 2008) (Shofiyana, 2026). However, implementing universal, population-level screening presents profound logistical and financial challenges within resource-constrained health systems (Kengne, 2024). Comprehensive laboratory-based screening requires substantial infrastructure, stable cold-chain transportation, and trained phlebotomists, which severely limits its feasibility and accessibility in underserved municipal settings (Ahuja, 2021). Universal biochemical examinations impose a notable participant burden due to the necessity of fasting states and repeated clinical visits, frequently resulting in poor compliance and inequitable screening coverage (Gerstle, 2025) (Hilda, 2024). To navigate these system limitations, contemporary public health pathways rely on a tiered framework, positioning non-invasive clinical risk assessment tools as primary filters to stratify population risk before deploying invasive diagnostic procedures(Echouffo-Tcheugui, 2011) .

The Finnish Diabetes Risk Score (FINDRISC) has gained widespread international validation as an accessible, non-invasive tool for initial population-level risk stratification (Lindstrom, 2003). By utilizing simple anthropometric, behavioural, and historical variables, the FINDRISC instrument estimates future diabetes risk with high operational feasibility in community-based screening programmes (Dangkrajang, 2025). Nevertheless, because it relies on a questionnaire-based architecture, the FINDRISC only identifies chronic risk exposure and cannot establish a formal clinical diagnosis or directly measure an individual's current glycaemic status (Meijnikman, 2018).The Oral Glucose Tolerance Test (OGTT) remains the definitive diagnostic standard for detecting early metabolic impairment, demonstrating superior sensitivity in identifying isolated post-challenge hyperglycaemia and impaired glucose tolerance compared to static fasting glucose or glycated haemoglobin

metrics (Jagannathan, 2020). Despite its physiological precision, the operational constraints of the OGTT including its two-hour duration, multiple venous samplings, and higher cost render it impractical for unselected mass application (Ahuja, 2021). Rather than treating these instruments as mutually exclusive alternatives, synthesizing them into a sequential protocol allows public health practitioners to balance the logistical simplicity of non-invasive screening with the high diagnostic accuracy of biochemical validation (Paulweber, 2010).

The conceptual utility of sequential screening, a distinct gap persists in the empirical literature regarding the operational validation and appropriate risk-score thresholds of the FINDRISC when paired with the OGTT within urban Indonesian populations. While the FINDRISC has been successfully adapted globally, its predictive accuracy is highly context-specific, as variations in body composition, dietary patterns, and genetic predispositions to beta-cell dysfunction can significantly alter the relationship between non-invasive scores and physiological dysglycaemia in Southeast Asian cohorts (Rokhman, 2022). Previous screening initiatives in Indonesia have predominantly relied on opportunistic fasting plasma glucose measurements, leaving substantial uncertainty regarding how effectively standard risk questionnaires correspond with the dynamic post-load glucose responses captured by the OGTT in a structured community framework (Siregar, 2023). Resolving this ambiguity is essential for public health practice; establishing a population-specific, calibrated screening threshold is required to prevent high rates of false negatives whilst ensuring that local primary care infrastructure is not overwhelmed by unnecessary diagnostic referrals. Consequently, an empirical evaluation of this dual-stage approach within an urban community setting is essential to refine targeted screening guidelines and optimize resource allocation. The primary objective of this study is to evaluate the screening performance and diagnostic accuracy of the FINDRISC questionnaire in identifying undiagnosed type 2 diabetes and dysglycaemia, using the OGTT as the reference standard, among adults within a community setting in Medan, Indonesia.

METHODS

This study was conducted in 6 six subdistricts in the Medan city from July14, 2020 to October 21, 2020. This is an observational study with cross sectional design. Sampel of 300 respondents aged 30 to 75 years that were selected from six subdisticts using purposive sampling.

After obtaining informed consent and ethical approval from School Medical, Universitas Sumatera Utara (Reference code number 129/KEP/ USU 2020), the participant's

data on FINDRISC questionnaire were collected through interviews including socio-demographic, behavioral, and made anthropometric measurement (weight, height and waist circumferences) by researcher. Height was measured using a Microtoise GEA stadiometer, and body weight was evaluated using a digital scale to determine body mass index.

The questionnaire consist of 8 items including age (< 45 years 0 points; 45-54 years 2 points; 55-64 years 3 points; ≥65 years 4 points), BMI (<25 kg/m2 0 points; 25-30kg/m2 1 point; ≥30 kg/m2 3 points), waist circumference (male: < 94 cm and female: <80 cm 0 points; male: 94–102cm and female: 80–88 cm 3 points; male: >102 cm and female: >88 cm 4 points), physical activity, at least 30 minutes/day (yes 0 points; and no 2 points), daily consumption of fruits and vegetables (every day 0 points; not every day 1 point), history of antihypertensive drug treatment(no 0 points and yes 2 points), history of high blood glucose (whether the respondent had ever been found to have high blood glucose in a health examination during an illness or during pregnancy(no 0 points and yes 5 points) and

family history of Type 2 diabetes melitus, score according to relatives with Type 2 diabetes mellitus diagnosis (no 0 points; yes: grandparent, relative, uncle, aunt 3 points; yes: parents, siblings, son, daughter 5 points). Then The results were categorized as low risk respondents had scoring < 7, slightly elevated risk respondents had scoring 7-11, medium risk respondents had scoring 12-14, high risk respondents had scoring 15-20 and very high risk respondents had scoring > 20. Furthermore, oral glucose tolerance test were performed for all respondents. The result of oral glucose tolerance test were categorized as normal was defined as capillary blood sugar < 90mg/dl, prediabetes was defined as capillary blood sugar 90-99mg/dl and diabetes as defined capillary blood glucose 100 mg/dl or more.

Data were analyzed using the Statistical Package for Social Science (Release 24.0 program, SPSS, Inc., Chicago, Illinois, USA). Descriptive analysis of the variables are presented as frequency distributions, mean ± standard deviation. Chi square test to determine difference between individual group.

RESULT

According to the distribution of component of the Finnish Diabetes risk score, of 300 repondents, 48.3 % respondents aged 45-54 years old, 37% had body mass index 25-30 kg/m2, 70% had central obesity, 80.7% have a daily fruit and vegetables consumption, 76.0% with physical activity, 50.0% had history of antihypertensive drug treatment, 90.3% had no history of high blood glucose, and 77.7% had no family history with diabetes (Table 2).

Table 1. Distribution of components of the Finnish Diabetes Risk Score in 300 respondents

Variable	Frequency	Percentage (%)
Age (years)		
< 45	81	27.0
45-54	145	48.3
55-64	62	20.7
>64	12	4.0
BMI ($kg/m^{2)}$		
< 25	92	30.7
25-30	111	37.0
>30	97	32.3
Waist circumference (cm)		
M :<94 F: < 80	90	30.0
M: 94-102 F:80-88	82	27.4
M:> 102 F : >88	128	42.6
Physical activity		
Yes	228	76.0
No	72	24.0
Vegetable and Fruits Consumption		
Daily	242	80.7
No daily	58	19.3
Hypertension		
With medication	150	50.0
Without medication	150	50.0
History of hyperglycaemia		
Yes	29	9.7
No	271	90.3
Family History with Diabetes mellitus		
No	233	77.7
Yes, grand parent	11	3.7
Yes, parents	56	18.7

This study showed that 33.7% of respondents had low risk of developing type 2 diabetes, 39.7% of respondents had slightly elevated risk, 20.0% of respondents had moderate risk, 5.3% of respondents had high risk and 0.7% of respondents had very high risk of developing type 2 diabetes (Table 2).

Table 2. Finnish Risk Score Questionnaire Results

Risk Diabetes category	Frequency	Percentage (%)
Low risk	101	33.7
Slightly elevated risk	119	39.7
Medium risk	62	20.7
High risk	16	5.3
Very high risk	2	0.7

The oral glucose tolerance test, 152 respondent (52.0%) with normal blood glucose, 54 respondents (18,0%) with prediabetes and 90 respondents with diabetes (Table 3.)

Table 3. Oral Glucose Tolerance Test Results

Results	Frequency	Percentage (%)
Normal	156	52.0
Prediabetes	54	18.0
Diabetes	90	30.0

The low risk of developing type 2 diabetes mellitus in the next ten years was found in 39(48.1%) of respondents younger than 45 years and 42 (67.7%) of respondents in 54-64 years had a moderate risk and 12 (19.4%) had a high risk ($p < 0.005$). The low risk was found in 56 (60.9%) of respondents with BMI< 25 kg/m^2 and 23 (23.7%) of respondents with BMI > 30 kg/m^2 had a high risk ($p<0.005$). The low risk was found in 86 (73.3%) of respondents had no central obesity and 142 (67.6%) of respondents central obesity had a moderate risk and 33 (15.7%) of respondents had a high risk ($p<0.005$). The low risk was found in 85 (37.3%) of respondents who practicing physical activity and 40 (55.6%) of respondents who not practicing physical activity had a moderate risk and 16 (22.2%) of respondents had a high risk ($p<0.005$). The low risk was found in 87 (81.5%) of respondents who used vegetables and fruits in daily diet and 30(51.7%) of respondents who did not use vegetables and fruits in daily diet had a moderate risk and 14 (24.1%) of respondents had a high risk ($p<0.005$). The low risk was found in 18 (12.0%) of respondents with hypertension treatment and 60 (40.0%) of respondents without hypertension treatment had a moderate risk and 7 (4.7%) of respondents had a high risk ($p<0.005$). The low risk was found in 10 (37.3%) of respondents without history of hyperglycaemia and 22 (75.9%) of respondents with history of hyperglycaemia had a high risk ($p<0.005$). The low risk was found in 99 (42.5%) of respondents had no family history with diabetes and 23 (34.3%) of respondents had family history with diabetes had a high risk ($p<0.005$) Table 4).

Table 4. The Risk of Developing Type 2 Diabetes Mellitus According to The Finnish Risk Score Components

Variable	Number (%) Respondents at Risk of Developing Diabetes			p
	Low Risk	Moderate Risk	High Risk	
Age (years)				
< 45	39 (48.1)	36 (44.4)	6 (7.4)	
45-54	51 (35.2)	71 (54.5)	15 (10.3)	0.001
54-64	8 (12.9)	42 (67.7)	12 (19.4)	
>64	3 (25.0)	8 (66.7)	1 (8.3)	
BMI (kg/m^2)				
< 25	56 (60.9)	32 (34.8)	4 (4.3)	0.000
25-30	41 (36.9)	63 (56.8)	7 (6.3)	
>30	4 (4.1)	70 (72.2)	23 (23.7)	
Central obesity				
Yes	35 (16.7)	142 (67.6)	33 (15.7)	0.000
No	86 (73.3)	23 (25.6)	1(1.1)	
Physical Activity				
Yes	85 (37.3)	125 (54.8)	18 (7.9)	0.001
No	16 (22.2)	40 (55.6)	16 (22.2)	
Vegetables and fruits consumption				0.002
Daily	87 (81.5)	135 (55.8)	20 (8.3)	
Non daily	14 (24.1)	30 (51.7)	14 (24.1)	
Hypertension				
Without medication	83 (55.3)	60 (40.0)	7 (4.7)	0.001
With medication	18 (12.0)	105 (70.0)	27 (18.0)	
History of hyperglycaemia				
Yes	0 (0.0)	7 (24.1)	22 (75.9)	0000
No	10 (37.3)	158 (58.3)	12 (4.4)	
Family History with Diabetes mellitus				0.000
Yes	2 (3.0)	42 (62.7)	23 (34.3)	
No	99 (42.5)	123 (52.8)	11 (4.7)	

A total of 300 respondents in this study, 69 (68.3%) respondents with low risk of developing type 2 diabetes had normal blood glucose and 21 (61.8%) respondents with high risk had diabetes blood glucose ($p<0.005$) (Table 5).

Table 5. The Risk Category of Developing Type 2 Diabetes Mellitus and Oral Glucose Tolerance Test

Risk Category	Number (%) Respondents with oral Glucose Tolearnce Test			
	Normal	Prediabetes	Diabetes	p
Low risk	69 (68.3)	18 (17.8)	14 (13.9)	0.000
Medium risk	79 (47.9)	31 (18.8)	55 (33.3)	
High risk	8 (23.5)	5 (14.7)	21 (61.8)	

DISCUSSION

The present study demonstrates that advanced age, elevated body mass index (BMI), central adiposity, physical inactivity, inadequate daily fruit and vegetable intake, active hypertension treatment, a history of hyperglycemia, and familial predisposition act as

definitive, statistically significant drivers that shift individuals into moderate-to-high risk strata for developing type 2 diabetes mellitus within the next decade. Notably, clinical indicators of pre-existing metabolic strain specifically a personal history of elevated blood glucose and genetic inheritance exhibit the most profound associations with high-risk classification, whereas modifiable lifestyle behaviors serve as critical behavioral buffers against metabolic decline (Rokhman, 2022).

Evaluating the underlying physiological mechanisms, the substantial escalation of risk among individuals with elevated BMI and central obesity underscores the systemic role of visceral adiposity in driving insulin resistance. Visceral fat accumulation triggers a chronic cascade of subclinical inflammation and lipotoxicity, which severely suppresses peripheral glucose disposal. This metabolic vulnerability is compounded by physical inactivity and suboptimal nutritional habits, such as deficient fruit and vegetable consumption, which deprives the system of essential antioxidants and dietary fiber necessary to modulate postprandial glycemic excursions. These findings are highly consistent with global epidemiological evidence establishing that the convergence of sedentary behavior and sustained metabolic strain accelerates pancreatic beta-cell depletion (Blond, 2023) (Costa, 2013). This research show extend prior research by confirming that non-invasive, population-specific risk tools can effectively map these lifestyle risk clusters within urbanizing adult cohorts experiencing rapid nutrition transitions (Siregar, 2023) (Dangkrajang, 2025).

From a clinical standpoint, the intense concentration of high-risk outcomes among individuals with a history of hyperglycemia and a positive family history illuminates the powerful contribution of genetic susceptibility and pre-existing beta-cell impairment. Chronic hyperglycemic exposure leaves a distinct metabolic memory that accelerates vascular damage, while a familial history reflects inherited defects in insulin secretion and hepatic glucose homeostasis (Abdul-Ghani, 2006) (Unwin, 2002). The heightened risk observed in patients undergoing hypertension treatment confirms the close pathophysiological clustering of metabolic and vascular diseases, driven by shared pathways of endothelial dysfunction and sympathetic overactivity (Shahim, 2018). This observation aligns with the modern cardiometabolic chronic disease framework, proving that opportunistic screening must prioritize these clinical comorbidities to capture post-challenge dysglycemia early (Nieto-Martinez, 2023) (Nieto-Martinez, 2023).

A primary methodological strength of this investigation lies in its deployment of a validated, multivariable risk-stratification pipeline (FINDRISC) linked with specific clinical metabolic parameters, which successfully overcomes the diagnostic limitations of static, single-modality screening in public health settings (Buijsse, 2011) (Paulweber, 2010). However, an inherent limitation is the cross-sectional architecture of the study, which restricts our ability to infer absolute causal directions over extended temporal horizons. Additionally, the reliance on self-reported lifestyle inputs introduces a susceptibility to recall bias, which may mask the nuanced impacts of specific behavioral sub-phenotypes within the target cohort (Misra, 2023).

At the policy level, municipal health departments should institutionalize systematic, non-invasive risk screening campaigns within community networks to detect subclinical dysglycemia early and curb rising macroeconomic expenditures on health care (Mühlenbruch, 2019) (Wang, 2021). In clinical and field practice, primary care practitioners should adopt this tiered diagnostic workflow, which reserves resource-intensive confirmatory laboratory tests such as the oral glucose tolerance test primarily for high-risk groups, thereby maximizing institutional efficiency and diagnostic outcomes (Ahuja, 2021) (Costa, 2012). Prospective longitudinal studies are urgently needed to validate digital health learning systems and implementation models capable of dynamically refining screening thresholds for ethnically diverse subpopulations undergoing rapid epidemiological transitions (Davies, 2022) (Green, 2024).

This study show the immense benefits of a sequential, risk-stratified screening paradigm in uncovering the hidden burden of undiagnosed metabolic diseases. Given that behavioral, clinical, and genetic risk factors are intrinsically linked to high risk scores, this study provides a robust framework for shifting from reactive clinical testing toward proactive and precision-based public health surveillance. Ultimately, early identification through this systematic framework provides a critical opportunity to implement intensive lifestyle and pharmacological interventions, thereby delaying disease progression and reducing long-term chronic complications (ElSayed, 2022) (Herman, 2015).

The Finnish Diabetes Risk Score (FINDRISC) can effectively distinguish between adults with normal glucose levels and those with diabetes, as confirmed by an oral glucose tolerance test. Individuals classified as low-risk by FINDRISC mostly exhibit normoglycemia, while the majority of those categorized as high-risk have glucose concentrations within the diabetic range. The screening strategy is useful in a two-stage approach, in which a non-invasive risk questionnaire identifies candidates most likely to benefit from definitive biochemical testing, thus aligning with contemporary frameworks for risk-adjusted diabetes detection (Abdallah, 2020) (Paulweber, 2010).

FINDRISC's predictive ability for undiagnosed dysglycemia. Previous multinational validation studies have shown that a high FINDRISC score correlates with a higher probability of detecting type 2 diabetes and impaired glucose tolerance when an oral glucose tolerance test (OGTT) is subsequently performed (Franciosi, 2005) (Wu, 2014). The convergence observed here between risk score stratification and gold-standard biochemical testing supports the hypothesis that incorporating simple, questionnaire-based triage can reduce the logistical and economic barriers inherent in universal laboratory screening (Salinero-Fort, 2016) (Salinero-Fort, 2016).

The components of FINDRISC which include age, body mass index, waist circumference, physical inactivity, dietary patterns, history of antihypertensive medication use, prior hyperglycemia, and family history of diabetes are all established risk factors associated with insulin resistance and progressive β-cell dysfunction (Lindstrom, 2003). The OGTT, by measuring the dynamic response to a glucose load, reveals post-challenge hyperglycemia that is often overlooked by fasting assessments alone (Unwin, 2002) (Abdul-Ghani, 2008). High-risk groups identified by FINDRISC likely already have a pathophysiological substrate involving impaired insulin secretion and/or action that only becomes apparent under the physiological stress of a glucose load. Isolated post-glucose-load hyperglycemia carries a significant risk of future cardiovascular morbidity and diabetes, and its detection requires provocative tests beyond fasting glucose or HbA1c (Saydah, 2001) (Meigs, 2002).

CONCLUSION

The Finnish Diabetes Risk Score (FINDRISC) serves as a highly effective and non-invasive primary stratification tool for identifying undiagnosed type 2 diabetes and dysglycemia in urban communities in Indonesia. The empirical agreement between questionnaire-based risk categories and the Oral Glucose Tolerance Test (OGTT) the gold standard confirms that FINDRISC successfully distinguishes between various levels of

metabolic disorders, with the majority of low-risk individuals exhibiting normoglycemia and the majority of high-risk individuals exhibiting glucose concentrations indicative of diabetes. These findings indicate that advanced age, high body mass index, central adiposity, physical inactivity, inadequate fruit and vegetable intake, active treatment for hypertension, and a personal or family history of dysglycemia act as statistically significant drivers accelerating an individual's progression to higher metabolic risk strata.

At the policy and epidemiological levels, these findings offer a robust framework for shifting urban health strategies from reactive clinical testing toward proactive, precision-based public health surveillance. The implementation of this two-stage sequential screening paradigm in which non-invasive clinical risk assessment tools serve as the primary screener before resorting to resource-intensive invasive laboratory diagnostics directly addresses the logistical and financial constraints inherent in urban health systems with limited resources. By selectively allocating oral glucose tolerance tests only to high-risk groups, primary care infrastructure can optimize institutional efficiency, improve diagnostic outcomes, and implement timely lifestyle or pharmacological interventions to halt subclinical metabolic decline before permanent physiological complications arise.

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