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RESEARCH ARTICLE

Predictors of Blood Lipid and Renal Function Screening among Adults in a Peri-Urban Community in Ghana: A Combined Logistic and Dominance Analysis Approach

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ABSTRACT

Objective: **Despite the critical role of screening in reducing the burden of non-communicable diseases (NCDs), its uptake remains low, particularly in peri-urban settings. This study aimed to identify and rank predictors of screening behaviors for blood lipid/cholesterol and renal function in a peri-urban community in Ghana.**

Methods: **Secondary cross-sectional data from 136 adults aged 18–60, collected in January 2023, were analyzed. Associations and relative importance were examined using bootstrapped logistic regression and dominance analysis models.**

Results: **Multivariate logistic regression analysis identified age (35-60 years) (aOR:7.6, 95% CI: 1.2–50.6) and employment status (aOR:4.4, 95% CI: 1.1–17.6) as significant predictors of renal screening. For blood lipid screening, significant predictors included body mass index (BMI) screening (aOR:3.6, 95% CI: 1.4–9.1) and diploma-level education (aOR:5.4, 95% CI: 1.3–21.8). Dominance analysis, which assesses the relative importance of predictors, revealed that age, blood glucose screening, and employment were the most important predictors for renal screening. In contrast, BMI and a history of raised blood pressure were the leading predictors for blood lipid screening.**

Conclusions: **These findings highlight the need for targeted health promotion strategies that integrate comprehensive screening packages within broader health services, addressing the specific needs of various educational and occupational groups. Enhanced public health interventions could improve screening rates and contribute to better management of NCDs in peri-urban settings.**

Keywords: Dominance analysis, Ghana, non-communicable diseases, screening.

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1. Introduction

NCDs such as cardiovascular diseases (CVD) and chronic kidney disease (CKD) have emerged as leading causes of morbidity and mortality globally, with a particularly high impact in low- and middle-income countries (LMICs) like Ghana [1]–[5]. In response to this growing challenge, screening has been recognized as a key strategy to mitigate the rising burden of NCDs [6]–[8], especially for conditions like CVD and CKD [9]–[11]. However, screening rates for renal function and blood lipids-key indicators for these diseases remain unacceptably low [6], [12], [13].

Cardiovascular disease (CVD) is the leading cause of death globally, with its prevalence surging dramatically from 257 million cases in 1990 to 523 million in 2019, accompanied by a rise in mortality of 6 million over the same period [14]. High levels of blood lipids, particularly cholesterol, are well-established risk factors for CVD [15] and contribute significantly to the burden of the disease in Africa [5], [16]. In Ghana, the World Health Organization (WHO) estimated that the probability of dying from CVD, cancer, diabetes, or chronic respiratory diseases between the ages of 30 and 70 was 22.5% in 2019 [17]. Reports indicate that poor blood lipid profiles are prevalent among

adults in rural and urban areas of Ghana [18]–[20], highlighting the urgent need to boost screening efforts and implement targeted preventive measures.

Similarly, the global burden of CKD has risen alarmingly, affecting an estimated 843 million people as of 2017 [14], [21]. Sub-Saharan Africa, including Ghana, has seen a troubling increase in CKD prevalence [22]–[27]. Major risk factors for both CVD and CKD, such as hypertension, diabetes, and obesity [27], [28], further underscore the critical importance of regular health screenings for early detection and management.

Although the burden of non-communicable diseases (NCDs) continues to rise, screening rates for essential risk factors remain low in various parts of Ghana [12], [29]. The Ghana National Policy on Non-Communicable Diseases points out the significance of screening and early detection as key strategies to reduce NCD prevalence [30]. Nevertheless, the factors influencing screening behaviors, particularly in peri-urban areas where access to healthcare and levels of health literacy can vary greatly, are not yet fully understood.

This study seeks to apply logistic regression alongside dominance analysis to uncover the key factors influencing screening behaviors in a peri-urban Ghanaian population. The insights gained will be crucial in shaping health promotion strategies and interventions that address the specific needs of this community. By improving non-communicable disease (NCD) outcomes, this research will also lay the groundwork for future studies in this field.

2. Method

2.1. Study Design

The methodology was developed following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [31]. This current study utilized a cross-sectional design to examine and rank predictors for blood lipid and renal function screenings. This design was appropriate given the nature of secondary data, as it does not require a follow-up period. Furthermore, the design allows for the description of distribution patterns and the examination of associations between predictor and outcome variables.

2.2. Participants and Data Collection

The data for this study have been previously described [12]. In January 2023, 150 adults aged 18–60 from the Dunkwa Post Office community in Upper Denkyira East Municipality, Ghana, were invited to participate in a study on health screening uptake. Convenience sampling was used to recruit participants who were available at their homes or workplaces during the visit. Of the 150 respondents, 14 (9.3%) declined to participate, resulting in a final sample of 136 participants, yielding a 91% participation rate. Non-respondents were not included in the analysis. Data collection involved administering a pre-tested questionnaire in a demographically similar community. The questionnaire covered sociodemographic variables, history of raised blood pressure and glucose, and previous screening for NCD risk factors. Individuals under 18 or over 60 years of age were excluded from the study. Ethical approval was granted by the Research and Ethics Committee of the Ghana Institute of Management and Public Administration (GIMPA), and informed consent was obtained from all participants. The current study analyzes data from all 136 participants from the primary survey.

2.3. Measures

2.3.1. Outcome Variables

The outcome variables for this study are the history of screening for blood lipid and renal function. The original study assessed these outcomes using the questions: "Have you done a kidney function test in the past 3 years?" and "Have you done a blood lipid profile test in the past 3 years?". Responses were dichotomized as 'yes' or 'no' and will be used as dependent variables in the logistic regression models.

2.3.2. Predictor Variables

Nine predictor variables were included in the study. The original dataset included sex (male/female), age groups (18–25, 26–35, 36–45, 46–60), employment status (non-employed, student, employed), and educational history (high school/O level, diploma, bachelor's, master's, PhD). For the current study, the age groups '36–45' and '46–60' were collapsed into '36–60', and 'non-employed' and 'student' were combined into 'non-employed'. Additionally, 'master's' and 'PhD' levels were collapsed into 'post-graduate' due to small sample sizes ($n < 7$) in some categories.

Screening for blood pressure in the past 12 months, blood glucose in the past 12 months, and BMI in the past 2 years were all dichotomized as 'yes' or 'no.' The history of raised blood pressure and raised blood glucose levels was assessed with the questions: "Have you ever been told by a doctor or other health worker that you have raised blood pressure or hypertension?" and "Have you ever been told by a doctor or other health worker that you have raised blood glucose or diabetes?", respectively.

2.4. Analysis Strategy

Analyses were conducted at a 95% confidence level ($\alpha = 0.05$). Summary statistics were reported using frequencies and percentages for all variables. Associations between the dependent and predictor variables were examined using logistic regression and dominance analysis models. Logistic regression was chosen as the primary analytical method due to its suitability for modelling the probability of a binary outcome based on one or more predictor variables [32]. In this study, the dependent variables' history of blood lipid screening' and 'history of renal function screening' were binary (yes/no) outcomes. Logistic regression is particularly appropriate for this analysis as it allows for estimating the odds of these events occurring concerning various predictor variables. Bivariate logistic regression analyses were conducted to identify significant predictors to be included in the multivariate logistic models. Dominance analysis was run for each multivariate logistic model. Dominance analysis provides a broader evaluation by considering each predictor's impact across various model scenarios, potentially revealing its importance even

if it doesn't appear statistically significant in the regression model [33], [34]. To enhance the robustness and reliability of the findings, bootstrapping with 5000 iterations was employed for all logistic (bivariate and multivariate) and dominance analyses. Bootstrapping is a resampling technique that involves repeatedly sampling, with replacement, from the original data set to create multiple simulated samples [35], [36]. In this study, 5000 bootstrapped samples were generated from the data, with replacement, to estimate the standard errors and confidence intervals and to assess the stability of the regression coefficients. This approach is particularly valuable in logistic regression and dominance analysis, as it mitigates the potential impact of sample variability, especially in cases where traditional assumptions may not hold, or the sample size is limited. All data analyses were performed using STATA v18.5.

3. Results

3.1. Summary Statistics

A total of 136 participants were included in the study, with a higher proportion being females (63.2%). Most of the participants were within the 26–35 age group (69.9%), and the majority were employed (77.2%). Participants with high school/O level (35.3%) certificates formed the majority, with a few having post-graduate (6.6%) qualifications.

Screening rates varied among different health parameters: 64.0% of participants reported having undergone blood glucose screening, 70.6% for blood pressure, and 51.5% for BMI in the past year. A history of high blood pressure was reported by 16.9% of participants, while only 5.9% reported a history of high blood glucose levels. Blood lipid screening was performed by 35.3% of the participants, and renal function screening was reported by 27.9% (Table I).

TABLE I: Summary Statistics (N = 136)

Variables	Levels	N (%)
Gender	Male	50 (36.8)
	Female	86 (63.2)
Age (in years)	18–25	18 (13.2)
	26–35	95 (69.9)
	36–60	23 (16.9)
Employment	Non-employed	31 (22.8)
	Employed	105 (77.2)
Educational level	High school/O level	48 (35.3)
	Diploma	29 (21.3)
	Bachelors	50 (36.8)
	Masters/PhD	9 (6.6)
Blood glucose screening	No	49 (36.0)
	Yes	87 (64.0)
Blood pressure screening	No	40 (29.4)
	Yes	96 (70.6)
Body mass index screening	No	66 (48.5)
	Yes	70 (51.5)
High blood pressure history	No	113 (83.1)
	Yes	23 (16.9)
High blood glucose history	No	128 (94.1)
	Yes	8 (5.9)
Blood lipids screening	No	88 (64.7)
	Yes	48 (35.3)
Renal function screening	No	98 (72.1)
	Yes	38 (27.9)

3.2. Bivariate Analysis

The bivariate logistic regression analysis identified several significant predictors for renal and lipid screening. For renal function screening, age (36–60 years) (OR:7.3, 95% CI: 1.7–32.2), employment status (employed) (OR:4.7, 95% CI: 1.3–16.4), blood pressure screening (OR:4.9, 95% CI: 1.5–16.7), blood glucose screening (OR:4.2, 95% CI: 1.4–12.1), and BMI screening (OR: 2.3, 95% CI: 1.0–5.1) were significant predictors. For blood lipid screening, the significant predictors were diploma-level education (OR:5.4, 95% CI: 1.8–16.1), blood glucose screening (OR:3.0, 95% CI: 1.3–7.3), BMI screening (OR:4.1, 95% CI: 1.8–9.2), and high blood pressure history (OR:3.6, 95% CI: 1.3–9.8) as seen in Table II.

3.3. Multivariate Analysis and Dominance Analysis

In the multivariate logistic regression for renal function screening, those in the age group 36–60 years were 7.6 times more likely to screen for renal function compared to those aged 18–25 years (aOR:7.6, 95% CI: 1.2–50.6), with all other variables held constant. Being employed was also associated with four times increased likelihood (aOR:4.4, 95% CI: 1.1–17.6) of screening for renal function as compared with those not employed, with all other variables held constant. Dominance analysis revealed age (sds = 0.2559), blood glucose screening (sds = 0.2114), and employment (sds = 0.2021) as the highest predictors of relative importance for renal screening. Blood pressure screening (sds = 0.1982) and BMI screening (sds = 0.1324) were the lowest-ranked predictors (Table III).

For blood lipid screening, the multivariate model revealed that those who screened for BMI had a higher likelihood (aOR:3.6, 95% CI: 1.4–9.1) of screening for blood lipids compared to those who did not, with all other variables held constant. Also, participants with a diploma level education were 5 times more likely to screen for blood lipids (aOR:5.4, 95% CI: 1.2–24.1) than those with high school level education. Dominance analysis identified BMI screening as the highest predictor of relative importance (sds = 0.4977), followed by high blood pressure history (sds = 0.2240), blood glucose screening (sds = 0.2239), and diploma education (sds = 0.0545) in that order (Table IV).

Stratified analyses by gender and interaction terms between gender and age, as well as gender and education, were also examined; however, no significant results were observed ($p > 0.05$).

4. Discussion

This study aimed to identify and rank the predictors of blood lipid and renal function screening in a peri-urban community in Ghana, revealing critical insights into factors influencing screening behaviors.

Globally, abnormal blood lipids/cholesterol have been recognized as a major risk factor for CVD, which remains the leading cause of mortality and morbidity [37]–[39].

TABLE II: Bivariate Analysis of Renal and Lipids Screening with Predictor Variables

Variables (n = 136)	Model 1: ORunadj (95% CI)[a]	Model 2: ORunadj (95% CI)[b]
Gender (male)	NS	NS
Age (36-45)	7.3** (1.7–32.1)	NS
Employment (employed)	4.7* (1.3–16.4)	NS
Education level (diploma)	NS	5.4** (1.8–16.1)
Blood pressure screening (yes)	4.9** (1.5–16.7)	NS
Blood glucose screening (yes)	4.2** (1.4–12.1)	3.0* (1.3–7.3)
BMI screening (yes)	2.3* (1.0–5.1)	4.1*** (1.8–9.3)
High blood pressure history (yes)	NS	3.6* (1.3–9.8)
High blood glucose history (yes)	NS	NS

Note. [a] Unadjusted odds ratio and 95% confidence interval for renal screening with 5000 bootstrapped replications. [b] Unadjusted odds ratio and 95% confidence interval for lipids screening with 5000 bootstrapped replications. NS: model/results not statistically significant; *p < 0.05; **p ≤ 0.01; ***p ≤ 0.001.

TABLE III: Multivariate Analysis of Renal Screening with Significant Predictors (Model 1)

Variables (n = 136)	AOR (95% CI)[a]	Standardized dominance statistic (sds)	Ranking
Age (35-45)	7.6* (1.2–50.6)	0.2559	1
Blood glucose screening (yes)	NS	0.2114	2
Employment (yes)	4.4* (1.1–17.6)	0.2021	3
Blood pressure screening (yes)	NS	0.1982	4
Body mass index screening (yes)	NS	0.1324	5

Note. [a] Bootstrapped adjusted odds ratio, 95% confidence interval, and dominance analyses (k = 5000); *p < 0.05.

TABLE IV: Multivariate Analysis of Blood Lipids Screening with Significant Predictors (Model 2)

Variables (n = 136)	AOR (95% CI)[a]	Standardized dominance statistic (sds)	Ranking
Body mass index screening (yes)	3.6** (1.4–9.1)	0.4977	1
High blood pressure history (yes)	NS	0.2240	2
Blood glucose screening (yes)	NS	0.2239	3
Education level (diploma)	5.4* (1.3–21.8)	0.0545	4

Note. [a] Bootstrapped adjusted odds ratio, 95% confidence interval, and dominance analyses (k = 500); *p < 0.05; **p ≤ 0.01.

Between 1990 and 2019, the prevalence of CVD increased from 257 million to 523 million, resulting in a 6 million rise in mortality over this period [40]. Reducing the burden of abnormal lipid levels is therefore essential to mitigating the overall impact of CVD. Previous studies have identified increasing age, unemployment, diabetes, and hypertension as significant risk factors for abnormal blood lipids in Ghana and other parts of Africa [16], [41], [42].

Our findings reveal a strong correlation between BMI screening and the uptake of lipid screening, indicating that individuals who monitor their BMI are more likely to participate in comprehensive NCD risk factor screenings. This supports the Ghana National Policy on Non-Communicable Diseases, which underscores the importance of screening and early detection [30]. Moreover, our results are consistent with those of Agongo *et al*. [20], who identified BMI and education as significant predictors of abnormal blood lipid levels among adults in rural northern Ghana. To enhance public health interventions, the results of the logistic and dominance analyses support the development of comprehensive screening packages that include lipid and glucose screening tests, with a heightened focus on individuals with existing conditions like hypertension. This approach ensures that high-risk groups receive targeted preventive care and regular screenings.

Interestingly, our study found that individuals with a diploma were more likely to undergo lipid screening, while those with bachelor's or post-graduate degrees did not show a significant increase in screening rates. This suggests that the relationship between education and health behaviors, such as lipid screening, may vary across educational levels. Despite the general association between higher education and better health outcomes [43], [44], it appears that diploma holders may have access to targeted health information or workplace wellness programs that encourage regular screenings. Conversely, those with higher degrees might prioritize other concerns, potentially leading to lower engagement in preventive behaviors. This finding aligns with a study from Ghana, which reported low screening rates for NCD risk factors among university lecturers despite their high educational attainment [29]. These results underscore the necessity of tailoring health promotion strategies to different educational groups, particularly those with higher educational levels, who may not prioritize preventive health measures.

The global burden of CKD has risen significantly, affecting an estimated 843 million people in 2017 [14], [21], [22]. In sub-Saharan Africa, including Ghana, CKD prevalence is notably high, with 13.3% of the population affected [23]. The risk factors for CKD have been identified to be increasing age, hypertension, diabetes, low level of education, and BMI [28], [45], [46]. The present study identified increasing age and employment as key predictors of renal screening uptake. As individuals age, their risk of developing NCDs such as hypertension and diabetes increases,

both of which are significant risk factors for CKD [46], [47]. Increased awareness of these risks may drive more frequent health screenings among older adults, who generally show higher engagement in preventive health measures [48]. Alternatively, the low screening rates among younger adults are worrying. The current population age structure in Ghana is predominantly young adults [49], highlighting the need to enhance screening efforts within this age group to address the growing burden of NCDs. Moreover, since this age group constitutes most of the working population, an increase in NCDs could adversely affect productivity through both presenteeism and absenteeism [50]–[52].

The study also found that employed individuals are more likely to undergo renal screening compared to their unemployed counterparts, highlighting a potential equity gap. Unemployment is a social determinant of health, and addressing it is crucial to equitable healthcare access [53]–[55]. In Ghana, the National Health Insurance Scheme (NHIS), a publicly funded healthcare system for equitable access and financial coverage for basic healthcare services to Ghanaian citizens, has been implemented over the past two decades. This has been a measure to scale up access towards universal primary healthcare [56]. However, the NHIS has faced challenges, including a broad benefits package and escalating costs [57], [58]. This potentially affects the widening of the scope of its exemption packages for groups like the unemployed [59]. These findings underscore the need for intersectoral collaborations and targeted funding to develop comprehensive screening programs for underserved populations such as the unemployed.

Furthermore, our dominance analysis revealed that screening for blood pressure, blood glucose, and BMI are predictors of relative importance for renal screening. Given that hypertension, diabetes, and obesity are well-established risk factors for CKD, it is crucial to implement integrated screening packages that include these assessments. This approach aligns with the Package of Essential Non-communicable (PEN) Disease Interventions for Primary Health Coverage by the World Health Organization, which identifies the need for integrated screening to help address the rising burden of NCDs [60]. The relative importance of these risk factors also highlights the interconnected nature of chronic disease management.

5. Strengths and Limitations

This study's key strength is its innovative use of dominance analysis, which provided a detailed ranking of the predictors influencing lipid and renal function screenings. This method goes beyond traditional regression analysis by identifying which factors have the most substantial impact, offering valuable insights for targeted public health interventions. This study also contributes uniquely to the understanding of NCD risk factor screening rates, an area with limited research.

Despite this analytical strength, the study has several limitations. The use of convenience sampling in the original survey introduces potential sampling bias. Since participants were not randomly selected, the findings may not accurately reflect the broader population of Dunkwa Municipality. This limitation restricts the generalizability of the results. To counteract this, bootstrapping techniques were employed, enhancing the robustness and reliability of the estimates, though the underlying bias cannot be eliminated. Another limitation is the risk of recall and social desirability biases, which may affect the accuracy of the data, as participants were asked to report on health screening activities over the past 12 to 36 months. Such retrospective reporting can lead to inaccuracies due to memory lapses or the tendency to provide socially desirable responses. The cross-sectional design of the study also restricts the ability to infer causality; while associations between predictors and screening behaviors were identified, the study cannot determine the temporal sequence of events. Longitudinal studies would be necessary to establish causal relationships definitively.

Despite these limitations, the study's use of odds ratios and the combination of logistic regression with dominance analysis offer a comprehensive understanding of the factors influencing health screening behaviors. These insights are essential for designing effective interventions aimed at improving screening rates.

6. Conclusion

The findings from this study have significant public health implications. To effectively increase screening rates for blood lipids and renal function, it is crucial to focus on younger adults, the unemployed, and individuals with higher educational levels. Tailored health promotion programs that emphasize the importance of regular health screenings are essential for enhancing the early detection of NCDs and mitigating associated morbidity and mortality.

Additionally, the study highlights the strong influence of prior screening behavior on the likelihood of subsequent screenings. This suggests that promoting initial screenings, particularly during routine medical visits, could foster continuous health monitoring and have a lasting positive impact. By encouraging early engagement in preventive health behaviors, we can significantly reduce the overall burden of NCDs in peri-urban communities and beyond. Effective implementation of these strategies will be vital in addressing the rising prevalence of NCDs and improving public health outcomes.

7. Recommendations

Based on the study's findings, the following recommendations are proposed:

1. **Promotion of integrated screening programs:** To capitalize on the significant relationship between prior screenings (such as blood pressure, blood glucose, and BMI) and subsequent renal and lipid screenings, the implementation of integrated screening packages is recommended. These programs should simultaneously address multiple risk factors, particularly for individuals with existing conditions like hypertension and diabetes. Community health centers could organize comprehensive screening days, where participants receive assessments for blood pressure, glucose levels, BMI, renal function tests, and lipid

profiles in one visit, enhancing NCD prevention and early detection.

2. **Targeted health promotion for under-screened populations:** The study identified lower screening rates among younger adults, the unemployed, and individuals with higher educational levels. Public health interventions should be tailored to these groups, emphasizing the importance of regular screenings. Mobile health clinics can reach unemployed individuals and those in remote areas, offering free or subsidized screenings. Additionally, universities and workplaces can implement wellness programs that include regular health check-ups and educational workshops. These targeted initiatives can explore funding from private enterprises through corporate social responsibility, improving screening rates and promoting better health management.
3. **Advancement of methodological rigor in future research:** While this study employed robust statistical techniques such as bootstrapping and dominance analysis, future research should aim to enhance methodological rigor. Utilizing randomized sampling and longitudinal designs can improve the generalizability of findings and establish clearer causal relationships between predictors and health screening behaviors. This approach will offer valuable insights for designing more effective public health interventions and enhancing overall research outcomes.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

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