

Regional inequalities in concurrent anaemia and overweight/obesity among women in Ghana: a nationally representative analysis of the 2022 Ghana Demographic and Health Survey

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Abstract

Background

Ghana is experiencing persistent anaemia alongside a high and rising burden of excess adiposity among women. These conditions may coexist within the same woman, yet contemporary evidence on how this intraindividual double burden is distributed across Ghana's current 16 administrative regions is limited. We estimated the prevalence and regional distribution of concurrent anaemia and overweight/obesity and examined its socioeconomic and dietary patterning.

Methods

We analysed the 2022 Ghana Demographic and Health Survey. The analytical sample comprised 5,611 non-pregnant women aged 20–49 years with valid haemoglobin and body mass index measurements. Anaemia was defined using the DHS classification for non-pregnant women and overweight/obesity as BMI ≥ 25.0 kg/m². Survey-weighted national and regional prevalence estimates were calculated. Regional correspondence among anaemia, overweight/obesity and concurrent burden was assessed using Spearman rank correlations across 16 regions. Design-based modified Poisson regression estimated adjusted prevalence ratios (aPRs), and marginal standardisation estimated composition-adjusted regional prevalence.

Results

Anaemia affected 39.77% (95% CI 38.00–41.53) of women, overweight/obesity 50.22% (48.25–52.18), and concurrent anaemia and overweight/obesity 17.71% (16.24–19.19). Concurrent prevalence ranged from 6.10% (3.24–8.96) in North East to 26.88% (20.99–32.78) in Western Region. Regional concurrent burden correlated strongly with overweight/obesity prevalence ($p = 0.921$) but weakly with anaemia prevalence ($p = -0.159$). Compared with women aged 20–29 years, aPRs were 1.58 (1.29–1.93) at ages 30–39 and 2.08 (1.69–2.55) at ages 40–49. Compared with the poorest quintile, the richest quintile had an aPR of 2.84 (1.95–4.15). MDD-W, sweet beverages and sentinel unhealthy foods showed no clear independent associations. Regional heterogeneity persisted after standardisation.

Conclusions

Concurrent anaemia and overweight/obesity affects approximately one in six non-pregnant Ghanaian women aged 20–49 years and is geographically unequal. Its regional distribution follows the geography of excess adiposity more closely than that of anaemia. Integrated, geographically responsive double-duty nutrition strategies may be appropriate.

Background

Malnutrition is increasingly characterised by the coexistence of nutritional deficits and excess adiposity. The World Health Organization (WHO) describes the double burden of malnutrition as the simultaneous presence of undernutrition, including micronutrient deficiency or insufficiency, with overweight, obesity or diet-related noncommunicable diseases at population, household or individual levels [1, 2]. In low- and middle-income countries, this coexistence reflects nutrition transitions in which traditional nutritional problems persist while obesity and diet-related noncommunicable diseases increase [3, 4].

Women of reproductive age are particularly important in this transition. Anaemia remains a major global public-health problem and is an indicator within the Sustainable Development Goal framework [5, 26]. At the same time, overweight and obesity have risen rapidly among women in sub-Saharan Africa and are increasingly concentrated in urban and socioeconomically advantaged groups in many countries, although the social gradient may change as transitions progress [6–8]. The two conditions are not mutually exclusive. Multi-country biomarker analyses have shown that overweight/obesity can coexist with anaemia or micronutrient deficiencies within individual women, with age and socioeconomic position repeatedly emerging as important correlates [9].

The biological relationship between excess adiposity and anaemia is complex and should not be reduced to iron deficiency alone. Obesity-related inflammation may influence iron regulation through hepcidin and related pathways, but evidence among women of reproductive age remains heterogeneous [10]. Anaemia itself is multifactorial and may reflect nutritional deficiencies, infection and inflammation, haemoglobinopathies, blood loss and other causes. Consequently, haemoglobin-defined anaemia should not be interpreted as a direct measure of iron deficiency.

Ghana provides a particularly relevant setting. Earlier national DHS analyses documented a rapid rise in overweight/obesity among women alongside persistent undernutrition [11], and a systematic review found substantially higher overweight and obesity in women and urban residents, with marked geographic variation [12]. Recent longitudinal analysis of Ghana DHS data from 2003 to 2022 found that overweight and obesity among women aged 20–49 years reached approximately 50% in 2022, with obesity continuing to rise with age [13]. Economic inequalities in obesity have also persisted over successive Ghana DHS rounds [14].

Anaemia has remained persistent. The 2022 GDHS reported a high burden among non-pregnant women, and a recent analysis of the same survey estimated anaemia prevalence at 40.4% among non-pregnant women and identified BMI, wealth, residence and geographic zone among relevant correlates [15, 16]. Recent work examining national and regional anaemia trends in Ghana has further highlighted persistent geographic disparities and slow progress toward reduction targets [17].

Importantly, Ghanaian women have previously been shown to experience an intraindividual double burden. Analysis of the 2014 GDHS found that approximately 14% of non-pregnant women experienced anaemia together with an abnormal BMI phenotype, with overweight plus anaemia constituting the

largest component [18]. The 2017 Ghana Micronutrient Survey subsequently reported overweight/obesity in 39%, anaemia in 22%, and concurrent overweight/obesity and anaemia in 6.7% of non-pregnant women aged 15–49 years [19, 25]. These studies established the importance of within-woman coexistence but predated the 2022 GDHS and Ghana's contemporary 16-region structure.

At the wider regional level, a 2024 analysis of 108,161 women across 17 sub-Saharan African countries estimated a pooled co-occurrence prevalence of 12% and demonstrated substantial spatial heterogeneity [20]. However, a multicountry hotspot analysis does not answer the policy-relevant question of how the contemporary burden is distributed across Ghana's administrative regions or whether the geography of coexistence more closely resembles the geography of anaemia or excess adiposity.

This distinction matters because national averages can obscure regional nutritional transitions. Ghanaian research has linked obesity to urbanisation and local food environments, including evidence of obesogenic food environments in Accra [21]. If anaemia remains widespread while excess adiposity becomes increasingly geographically concentrated, regions with high coexistence may emerge through the superimposition of obesity on a persistent anaemia burden rather than through parallel geographic distributions of the two component conditions.

We therefore estimated national and region-specific prevalence of anaemia, overweight/obesity and their concurrent occurrence among non-pregnant women aged 20–49 years in the 2022 GDHS; compared the regional geographies of the three outcomes; examined socioeconomic and short-reference-period dietary patterning; and assessed whether regional heterogeneity persisted after standardising for measured population composition.

Methods

Study design and data source

We conducted a secondary cross-sectional analysis of the 2022 Ghana Demographic and Health Survey (GDHS). The survey was implemented by the Ghana Statistical Service in collaboration with the Ghana Health Service and ICF under The DHS Program. Data collection occurred from October 2022 to January 2023. The GDHS used a stratified, two-stage cluster sampling design and was designed to provide estimates for Ghana and its 16 administrative regions [16]. The women's Individual Recode file was used.

Study population

The primary analytical population comprised non-pregnant women aged 20–49 years with valid BMI and anaemia measurements. Women aged 15–19 years were excluded because conventional adult BMI thresholds are not appropriate for adolescents, while pregnant women were excluded because

pregnancy alters haemoglobin concentration and BMI interpretation. The final common analytical sample comprised 5,611 women.

Outcome definitions

Outcome definitions

Anaemia was defined from the DHS haemoglobin classification for non-pregnant women; mild, moderate and severe categories were combined as any anaemia. Overweight/obesity was defined as BMI ≥ 25.0 kg/m². Concurrent anaemia and overweight/obesity was defined as the presence of both conditions in the same woman. Four mutually exclusive phenotypes were also constructed: neither condition, anaemia only, overweight/obesity only, and concurrent burden.

Dietary indicators

Minimum Dietary Diversity for Women (MDD-W) was operationalised using the standard ten food groups, with consumption of at least five groups during the previous 24 hours classified as meeting MDD-W [22, 27]. MDD-W is a population-level food-group diversity indicator and proxy for micronutrient adequacy, not a comprehensive measure of overall dietary quality. Binary indicators were also constructed for sweet-beverage consumption and selected sentinel unhealthy foods. Because these indicators reflect a short reference period, they were interpreted as recent reported consumption rather than habitual diet.

Covariates

Prespecified covariates were age group (20–29, 30–39, 40–49 years), educational attainment, household wealth quintile, urban/rural residence, administrative region, MDD-W, sweet-beverage consumption and sentinel unhealthy-food consumption. Covariates were retained on substantive grounds rather than automated significance selection.

Survey design and descriptive analysis

The women's sampling weight (v005), primary sampling unit (v021) and sampling stratum (v022) were incorporated. Unweighted frequencies describe sample sizes; prevalence estimates and inferential analyses are survey weighted. National and regional prevalences with 95% confidence intervals were estimated for anaemia, overweight/obesity and concurrent burden. Regional precision was assessed using standard errors and relative standard errors.

Regional geographic comparison

For each of Ghana's 16 regions, prevalence estimates were generated for anaemia, overweight/obesity and concurrent burden. Spearman rank correlations were calculated across the 16 regional estimates to

quantify geographic correspondence. These are ecological comparisons and were not interpreted as individual-level associations. Expected coexistence under statistical independence was calculated as $P(\text{anaemia}) \times P(\text{overweight/obesity})$, with observed-to-expected ratios treated as secondary descriptive indices rather than measures of biological interaction.

Adjusted analysis

Adjusted prevalence ratios were estimated using a weighted modified Poisson model with log link. Taylor-linearized sandwich variances were derived from PSU score totals centred within sampling strata. The final design contained 618 PSUs in 32 strata and no lonely-PSU strata. A weighted logistic model with the same covariates was used for marginal standardisation of regional prevalence, with delta-method uncertainty based on the design covariance matrix.

Reporting, ethics and AI-assisted editing

Reporting was guided by STROBE and relevant STROBE-nut recommendations [23, 24]. The original GDHS protocol underwent ethical review through the Ghana Health Service and ICF processes described in the survey report, and informed consent was obtained under DHS procedures [16]. This analysis used de-identified data obtained through authorised DHS access and involved no direct participant contact. OpenAI’s ChatGPT was used for language refinement, organisation and editorial polishing. All scientific decisions, numerical results, references and interpretations were reviewed and verified by the authors, who retain responsibility for the manuscript.

Results

National prevalence

Among 5,611 women, 39.77% (95% CI 38.00–41.53) had anaemia and 50.22% (48.25–52.18) had overweight/obesity. Concurrent anaemia and overweight/obesity affected 17.71% (16.24–19.19), meaning that approximately one in six women experienced both conditions simultaneously. The coexistence estimate is epidemiologically important because it identifies women who would be incompletely characterised if anaemia and excess adiposity were considered as mutually exclusive nutritional problems.

Outcome	Weighted prevalence, %	95% CI
Anaemia	39.77	38.00–41.53
Overweight/obesity	50.22	48.25–52.18
Concurrent anaemia and overweight/obesity	17.71	16.24–19.19

Regional distribution and contrasting geographies

Concurrent burden varied markedly across the 16 regions. Western Region had the highest prevalence at 26.88% (95% CI 20.99–32.78), followed by Greater Accra at 22.32% (17.72–26.93) and Central at 21.87% (17.71–26.03). The lowest estimates were observed in North East (6.10%, 3.24–8.96), Upper East (8.13%, 4.76–11.50) and Upper West (9.28%, 6.01–12.56). Thus, the highest regional point estimate was approximately 4.4 times the lowest. The overall regional profiles are shown in Fig. 1, and the ranked concurrent-burden estimates with 95% confidence intervals are shown in Fig. 2.

Region	Anaemia %	Overweight/obesity %	Concurrent %	Concurrent 95% CI
Western	46.62	54.28	26.88	20.99–32.78
Greater Accra	37.29	62.02	22.32	17.72–26.93
Central	43.73	56.32	21.87	17.71–26.03
Ashanti	37.21	59.09	19.26	14.98–23.55
Eastern	36.46	55.33	18.06	13.12–23.01
Volta	39.66	51.55	17.80	12.97–22.62
Western North	34.70	50.69	15.91	11.75–20.06
Ahafo	32.97	50.06	15.87	11.92–19.82
Oti	49.14	32.27	13.05	7.76–18.34
Bono	28.16	50.20	11.67	6.75–16.59
Northern	46.65	27.39	11.63	7.92–15.35
Savannah	41.82	30.65	11.57	8.27–14.86
Bono East	37.60	39.25	10.69	7.19–14.18
Upper West	43.20	25.74	9.28	6.01–12.56
Upper East	44.81	27.70	8.13	4.76–11.50
North East	41.77	18.43	6.10	3.24–8.96

The component conditions displayed contrasting regional profiles. Anaemia was highest in Oti (49.14%) and Northern (46.65%), whereas overweight/obesity was highest in Greater Accra (62.02%), Ashanti (59.09%) and Central (56.32%). Consequently, regions with the highest anaemia prevalence were not necessarily those with the highest concurrent burden.

Across the 16 regions, anaemia and overweight/obesity showed a modest inverse rank correlation ($\rho = -0.385$). Concurrent burden correlated weakly with anaemia ($\rho = -0.159$) but very strongly with overweight/obesity ($\rho = 0.921$). This pattern indicates that the regional ranking of the concurrent phenotype resembled the geography of excess adiposity far more closely than the geography of

anaemia, although the ecological correlation does not establish causality. The contrasting regional profiles of the three outcomes are shown in Fig. 1.

The figure visually reinforces the divergent component geographies: regions with high anaemia are distributed differently from regions with high excess adiposity, while the concurrent-burden profile rises and falls in close parallel with overweight/obesity.

The ranked plot shows a clear separation between the highest- and lowest-burden regions, but overlapping confidence intervals among several intermediate regions caution against interpreting every adjacent rank as a statistically meaningful difference.

Standardisation attenuated some regional contrasts, most notably in Greater Accra, while increasing estimates in several northern regions. Western remained highest and North East among the lowest, indicating that measured demographic, socioeconomic and dietary composition explained only part of the regional heterogeneity.

Socioeconomic and dietary patterning

Crude concurrent prevalence increased monotonically with age, from 12.15% among women aged 20–29 years to 24.29% at ages 40–49. A similarly strong wealth gradient was observed, from 6.56% in the poorest quintile to 25.43% in the richest. Urban prevalence was 21.00%, compared with 13.14% in rural areas.

Comparison	aPR	95% CI	p value
Age 30–39 vs 20–29	1.58	1.29–1.93	< 0.001
Age 40–49 vs 20–29	2.08	1.69–2.55	< 0.001
Primary vs no education	1.18	0.87–1.59	0.289
Secondary vs no education	1.17	0.91–1.50	0.235
Higher vs no education	1.20	0.87–1.66	0.275
Poorer vs poorest	1.70	1.21–2.38	0.002
Middle vs poorest	1.91	1.32–2.78	< 0.001
Richer vs poorest	2.56	1.80–3.64	< 0.001
Richest vs poorest	2.84	1.95–4.15	< 0.001
Rural vs urban	0.92	0.75–1.12	0.395
MDD-W ≥ 5 vs < 5	0.99	0.86–1.13	0.835
Sweet beverages yes vs no	1.05	0.90–1.23	0.508
Unhealthy foods yes vs no	0.97	0.82–1.16	0.739

After multivariable adjustment, the age gradient persisted: women aged 30–39 years had 58% higher prevalence than those aged 20–29 (aPR 1.58, 95% CI 1.29–1.93), while women aged 40–49 had approximately twice the prevalence (aPR 2.08, 1.69–2.55). Household wealth also retained a graded association, reaching an aPR of 2.84 (1.95–4.15) in the richest versus poorest quintile. In contrast, education and rural residence were not independently associated after adjustment.

The short-reference-period dietary indicators also showed no clear independent associations: MDD-W $\geq$ 5 food groups had an aPR of 0.99 (95% CI 0.86–1.13), sweet-beverage consumption 1.05 (0.90–1.23), and sentinel unhealthy-food consumption 0.97 (0.82–1.16). These null findings do not imply that diet is unimportant; rather, the measured indicators did not independently distinguish the concurrent phenotype within this cross-sectional model.

Composition-adjusted regional prevalence

After marginal standardisation for age, education, wealth, residence and measured dietary indicators, Western remained the highest-burden region at 24.95% (95% CI 20.00–29.90). North East remained among the lowest at 11.45% (6.46–16.45). Greater Accra declined from an observed 22.32% to an adjusted 17.37%, whereas estimates increased in several northern regions. The persistence of substantial variation after standardisation suggests that regional population composition alone does not explain the observed geography. Observed and composition-adjusted regional prevalence estimates are compared in Fig. 3.

Region	Adjusted prevalence %	95% CI
Western	24.95	20.00–29.90
Central	21.39	17.31–25.46
Greater Accra	17.37	13.55–21.18
Volta	17.37	12.88–21.86
Eastern	16.88	12.40–21.37
Ashanti	17.80	13.92–21.67
Western North	17.61	13.27–21.96
Ahafo	19.18	14.15–24.22
Bono	12.18	7.23–17.14
Bono East	12.68	8.54–16.82
Oti	17.54	10.95–24.12
Northern	15.85	10.95–20.74
Savannah	18.29	13.20–23.39
North East	11.45	6.46–16.45
Upper East	12.96	8.51–17.41
Upper West	13.75	9.01–18.49

Discussion

This nationally representative analysis shows that concurrent anaemia and overweight/obesity is a substantial and geographically unequal nutritional phenotype among adult Ghanaian women. Approximately one in six non-pregnant women aged 20–49 years experienced both conditions. Regional prevalence differed more than fourfold, and the geography of coexistence corresponded far more closely with overweight/obesity than with anaemia. Older age and higher household wealth were strong independent correlates, while the measured short-reference-period dietary indicators were not.

The estimated 17.71% concurrent prevalence should be interpreted in relation to, but not directly equated with, earlier Ghanaian estimates. The 2014 GDHS analysis reported that about 14% of women experienced anaemia together with an abnormal BMI phenotype, although that definition included underweight as well as overweight/obesity [18]. The 2017 Ghana Micronutrient Survey reported 6.7% concurrent overweight/obesity and anaemia among non-pregnant women aged 15–49 years [19]. Differences in age eligibility, survey design, measurement context and outcome construction mean that these estimates do not establish a temporal increase by themselves. Nevertheless, the present 2022

estimate demonstrates that within-woman coexistence remains a major contemporary public-health issue.

Our findings are also consistent with the broader sub-Saharan African evidence. Getnet and colleagues reported 12% pooled co-occurrence across 17 countries and substantial spatial heterogeneity [20]. Multi-country biomarker analyses have similarly shown that the intraindividual double burden varies widely across populations and that older age and higher socioeconomic position often increase the likelihood of the phenotype in low- and middle-income settings [9]. Ghana's 17.71% estimate therefore lies toward the higher end of many reported population estimates, while remaining within the range observed internationally.

The most distinctive contribution is the comparison of the three regional geographies. Anaemia was relatively high in several northern and transitional regions, including Oti and Northern, while excess adiposity was concentrated more strongly in Greater Accra, Ashanti, Central and other southern regions. The concurrent phenotype closely followed the latter pattern. This does not mean that obesity causes anaemia, nor does the strong ecological correlation demonstrate an individual biological pathway. Mathematically, coexistence is constrained by both marginal prevalences. Epidemiologically, however, the contrast suggests that where anaemia remains sufficiently common, regional differences in excess adiposity may increasingly determine where high coexistence becomes visible.

This interpretation is compatible with Ghana's nutrition transition. National studies have documented a sustained rise in overweight and obesity among women over several decades [11–14]. Urbanisation, socioeconomic change and changing food environments have been implicated, while work in Accra has demonstrated local environments characterised by abundant convenience and prepared foods and associations between food-environment characteristics and BMI [21]. The persistence of anaemia alongside these changes creates conditions in which nutritional deficiency-related morbidity and excess adiposity can increasingly overlap within the same women.

The strong age gradient is also consistent with Ghanaian and international evidence. Recent age-period-cohort analysis of Ghana DHS data showed steep increases in obesity with age among women [13], while previous double-burden studies in Ghana and other countries have similarly identified older age as a correlate [9, 18–20]. Because anaemia remains prevalent across reproductive ages, accumulation of excess adiposity with age may increase the probability of within-woman coexistence.

The wealth gradient deserves particular attention. Concurrent prevalence increased from the poorest to the richest quintile even after adjustment. Earlier Ghanaian studies have consistently associated higher wealth with overweight/obesity [11, 18, 19], and recent analyses continue to document economic inequalities in obesity [14]. The present findings show why the double burden should not be framed exclusively as a problem of poverty. During Ghana's current stage of nutrition transition, socioeconomic advantage may increase exposure to environments and lifestyles conducive to excess adiposity without guaranteeing protection from anaemia.

By contrast, MDD-W, sweet beverages and sentinel unhealthy foods showed no independent association after adjustment. MDD-W is designed primarily as a population-level indicator of food-group diversity and micronutrient adequacy rather than a comprehensive measure of energy balance or obesity-related dietary quality [22]. Moreover, previous-day indicators have limited ability to represent habitual long-term intake, whereas BMI reflects cumulative energy balance. These measurement differences, together with the multifactorial aetiology of anaemia, provide plausible reasons why the short-reference-period dietary indicators did not independently predict the concurrent phenotype.

The biological relationship between obesity and iron-related outcomes is also not straightforward. A recent systematic review among women of reproductive age found heterogeneous associations between overweight/obesity, haemoglobin, iron deficiency and iron-deficiency anaemia, while studies measuring inflammation and hepcidin often reported higher levels among women with excess adiposity [10]. Our study did not measure ferritin, inflammatory markers or hepcidin and therefore cannot attribute anaemia to iron deficiency or obesity-related inflammation. This distinction is important when designing interventions.

The adjusted regional analysis further shows that geography cannot be reduced to population composition. Standardisation substantially attenuated Greater Accra's prevalence and raised estimates in several northern regions, indicating that age, wealth, residence and other measured characteristics contribute to crude differences. Yet Western remained highest and North East among the lowest. Residual regional heterogeneity may reflect unmeasured differences in food environments, physical activity, reproductive histories, infection and inflammation, haemoglobinopathies, health-service access and other contextual factors. These possibilities require dedicated multilevel or longitudinal investigation.

From a policy perspective, the findings support double-duty approaches rather than isolated responses to anaemia and obesity. WHO defines double-duty actions as interventions, programmes and policies with potential to reduce both undernutrition or micronutrient deficiency and overweight, obesity or diet-related noncommunicable disease [2]. For Ghana, this principle could include integrating anaemia assessment with weight and NCD-risk assessment in women's health services, improving nutrient density without promoting excessive energy intake, and ensuring that nutrition programmes targeting one form of malnutrition do not inadvertently worsen another. The pronounced regional variation further argues against assuming a uniform national nutritional profile.

Strengths and limitations

The study uses contemporary nationally representative data, objective haemoglobin and anthropometric measurements, all 16 current regions, design-based variance estimation, and direct comparison of the component and concurrent regional distributions. It also distinguishes ecological regional correspondence from individual-level association and uses marginal standardisation to examine whether population composition explains geographic differences. Limitations include the cross-sectional design,

which precludes causal inference; the ecological nature of regional correlations; absence of cluster coordinates for fine-scale hotspot analysis; BMI as an imperfect proxy for adiposity; inability of haemoglobin alone to identify anaemia aetiology; short-reference-period dietary measures; and residual confounding by unmeasured biological, behavioural and contextual factors.

Conclusions

Concurrent anaemia and overweight/obesity affects approximately one in six non-pregnant Ghanaian women aged 20–49 years and varies markedly across regions. The geography of coexistence resembles the geography of excess adiposity more closely than that of anaemia, while older age and greater household wealth are prominent independent correlates. Measured population composition explains part, but not all, of regional heterogeneity. Ghana's women's nutrition agenda may therefore benefit from integrated, geographically responsive double-duty strategies that address persistent anaemia without overlooking the growing burden of excess adiposity.

Abbreviations

aPR	
adjusted prevalence ratio	
BMI	
body mass index	
CI	
confidence interval	
DHS	
Demographic and Health Survey	
GDHS	
Ghana Demographic and Health Survey	
MDD-W	
Minimum Dietary Diversity for Women	
NCD	
noncommunicable disease	
PSU	
primary sampling unit	
WHO	
World Health Organization.	

Declarations

Ethics approval and consent to participate

The study used de-identified secondary data from the 2022 Ghana Demographic and Health Survey. The Ghana Statistical Service submitted the original survey protocol to the Ethical Review Committee of the Ghana Health Service, which granted ethical clearance and confirmed that the survey procedures complied with Ghana's ethical research standards. ICF also submitted the protocol to the ICF Institutional Review Board, which granted ethical clearance and confirmed compliance with U.S. and international ethical research standards. Informed consent was obtained from all participants under DHS procedures before data and biomarker collection. The present secondary analysis involved no direct participant contact and used de-identified data obtained through authorised DHS access. The present secondary analysis was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

SA: Conceptualization, methodology, data curation, formal analysis, software, validation, visualization, writing—original draft, and project administration. SKAB: data extraction, data curation, validation, and writing—review and editing. QD: contextual interpretation, validation, and writing—review and editing. GKD: supervision, methodological oversight, validation, and writing—review and editing.

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Data Availability

The data analysed in this study are from the 2022 Ghana Demographic and Health Survey (GDHS), collected as part of the Demographic and Health Surveys (DHS) Program. The datasets are not owned by the authors and therefore cannot be redistributed by the authors. De-identified survey microdata are available from the DHS Program upon registration and approval of a data access request. Interested researchers can obtain access through the DHS Program under the same conditions as the authors. The authors had no special or privileged access to the data.

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Figures

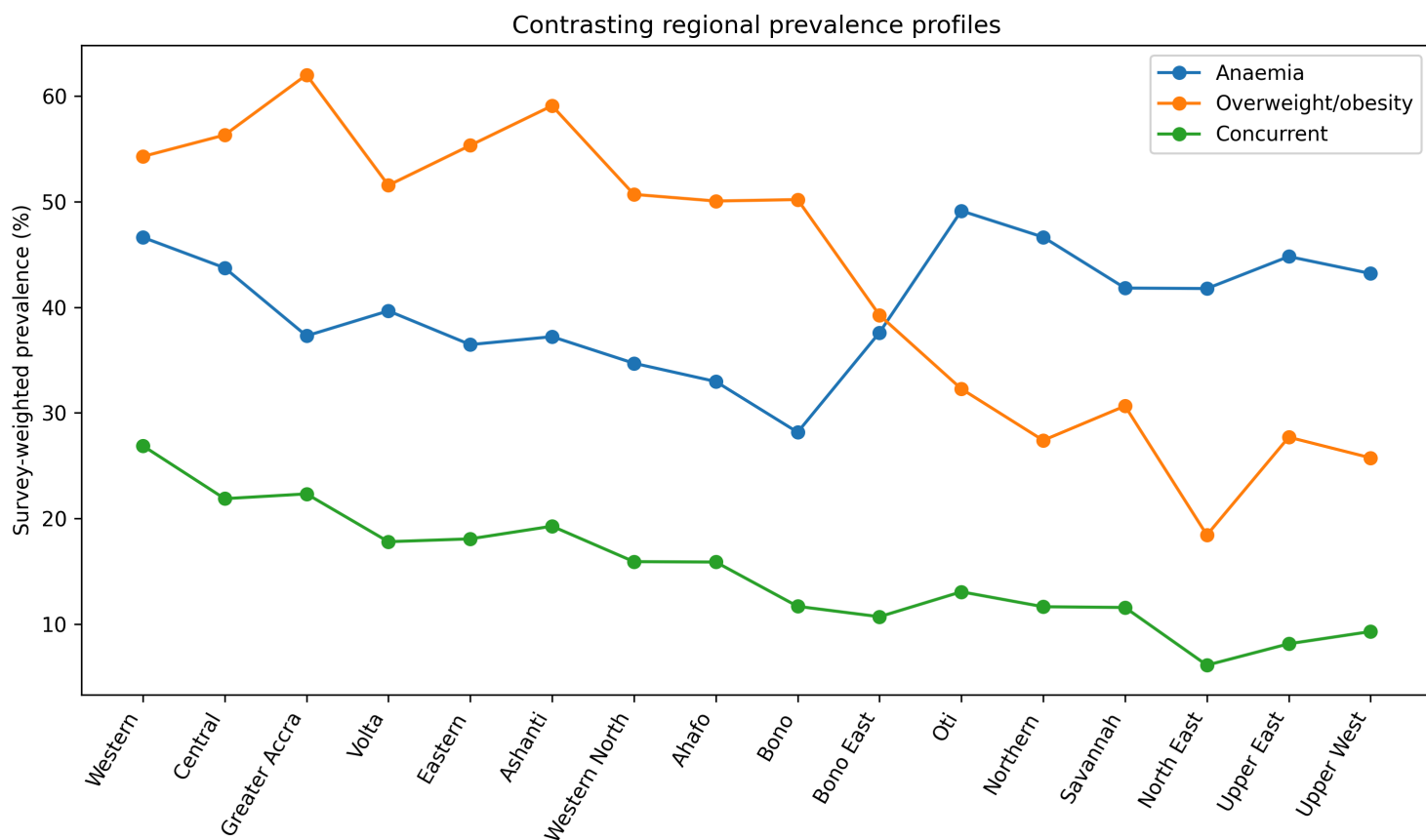


Figure 1

Regional profiles of anaemia, overweight/obesity and concurrent burden.

The figure visually reinforces the divergent component geographies: regions with high anaemia are distributed differently from regions with high excess adiposity, while the concurrent-burden profile rises and falls in close parallel with overweight/obesity.

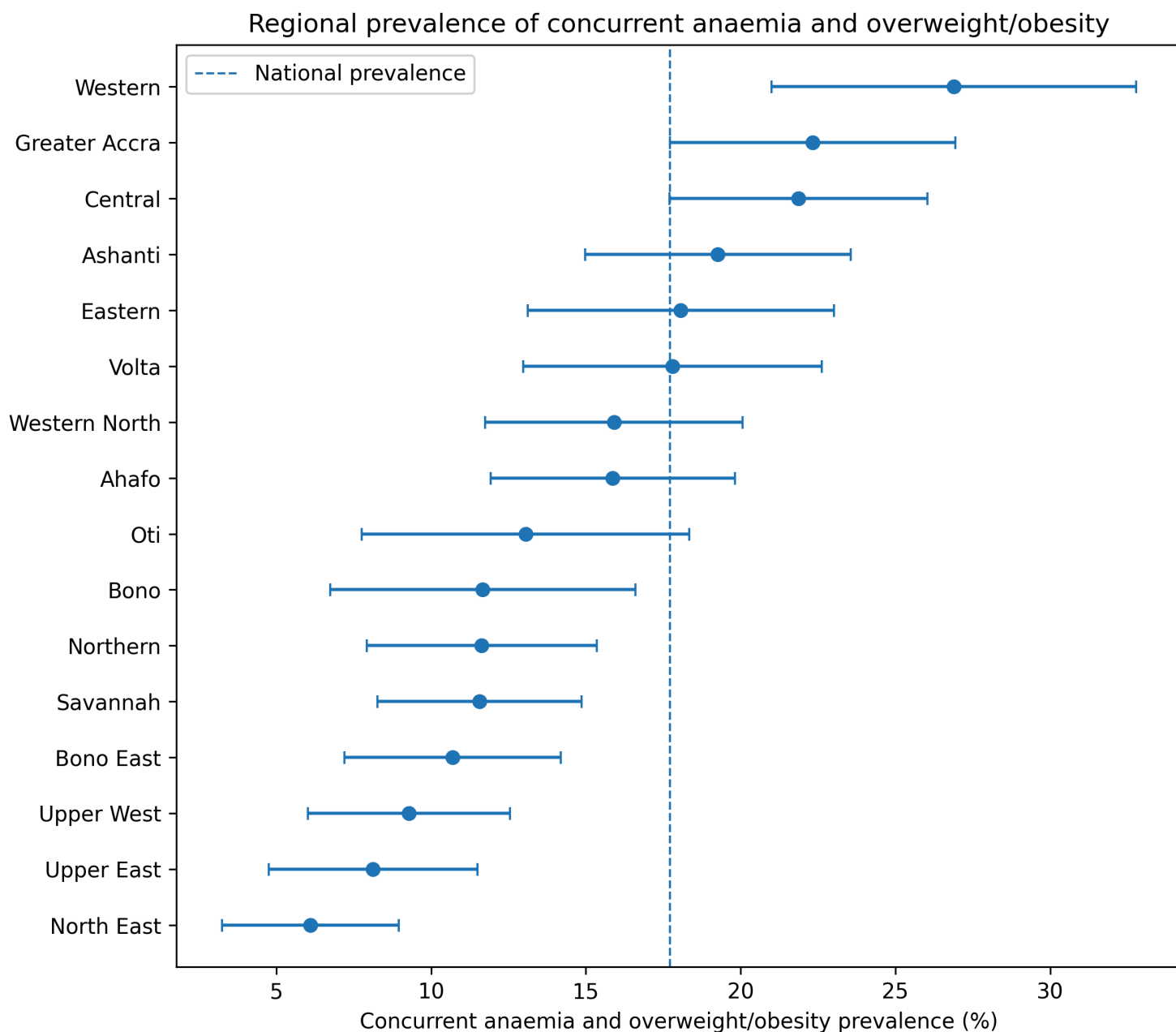


Figure 2

Ranked regional prevalence of concurrent anaemia and overweight/obesity with 95% confidence intervals.

The ranked plot shows a clear separation between the highest- and lowest-burden regions, but overlapping confidence intervals among several intermediate regions caution against interpreting every adjacent rank as a statistically meaningful difference.

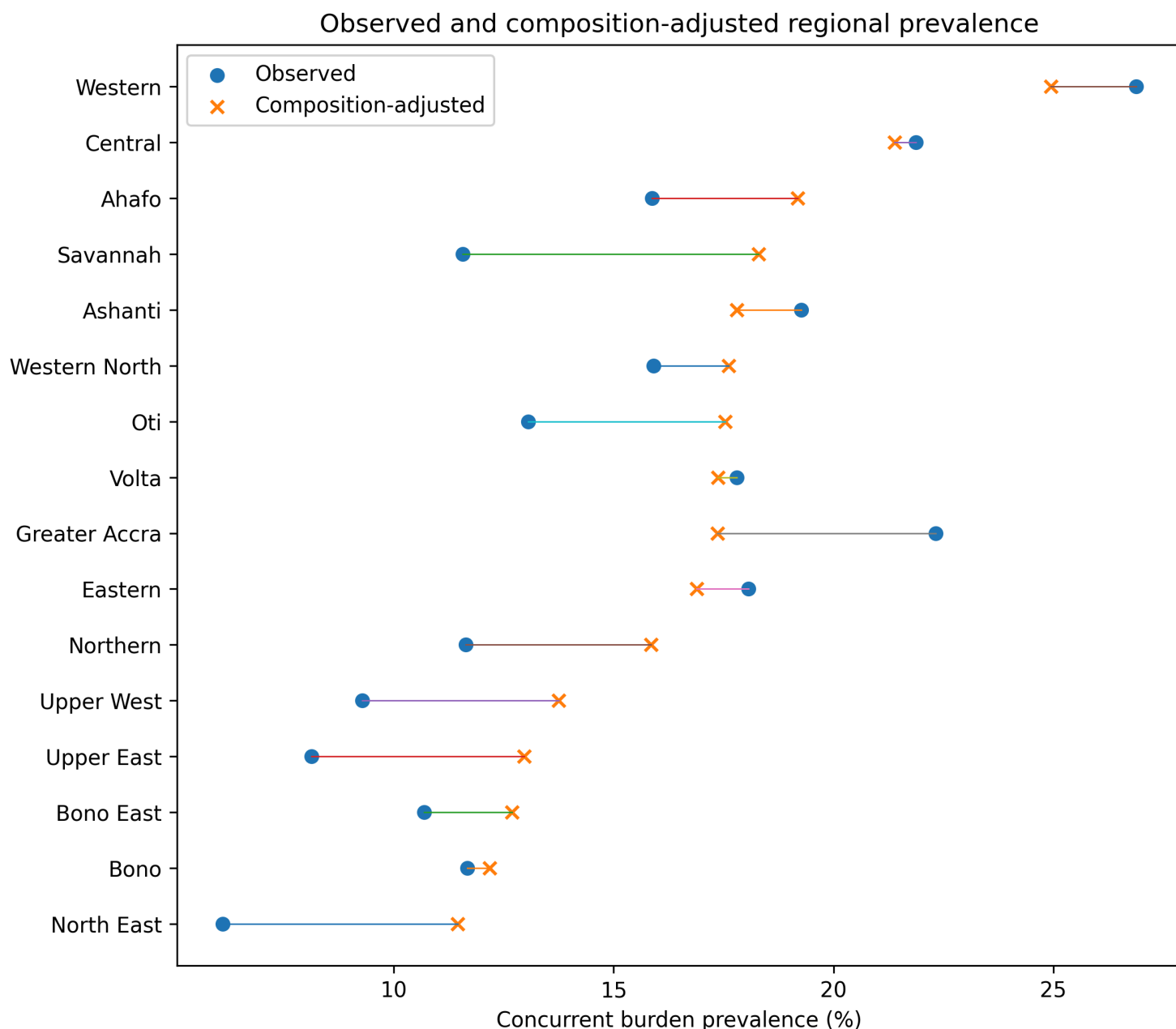


Figure 3

Observed and composition-adjusted regional prevalence of concurrent burden.

Standardisation attenuated some regional contrasts, most notably in Greater Accra, while increasing estimates in several northern regions. Western remained highest and North East among the lowest, indicating that measured demographic, socioeconomic and dietary composition explained only part of the regional heterogeneity.

Supplementary Files

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- [STROBEChecklist.docx](#)
- [SupplementaryMaterialTablesS1S5.docx](#)