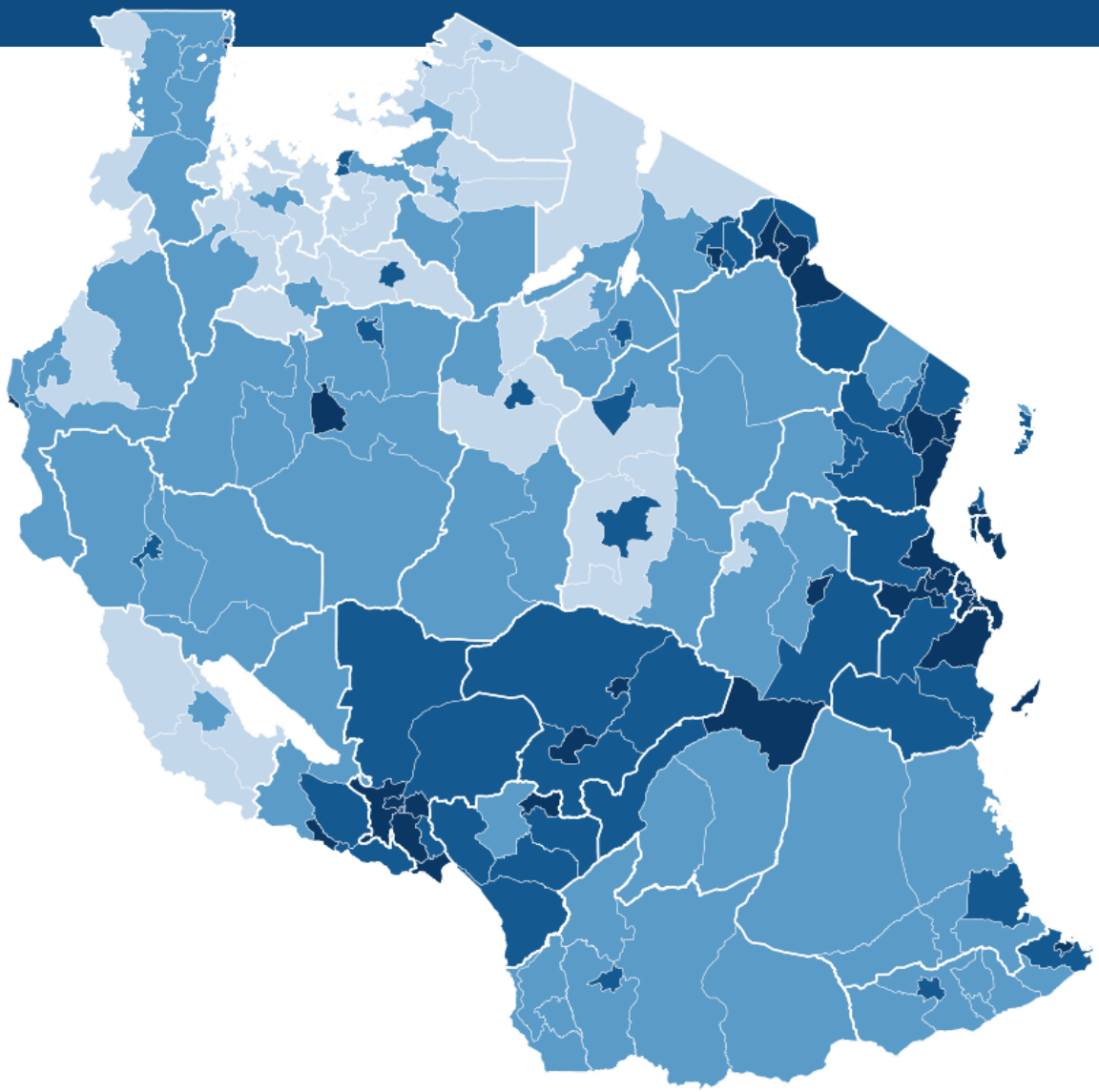
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SPACEPILOTS RESEARCH REPORT · PREVIEW EDITION

Overweight, Obesity and Hypertension among Women in Tanzania's Councils

Small area estimates of overweight, obesity and hypertension among women age 20–49 for 195 councils and 150 districts, 2022



Prepared by **SpacePilots** · www.spacepilots.io

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Disclaimer. The estimates in this report are model-based and were produced by SpacePilots. They are not official statistics of the National Bureau of Statistics (NBS), the Office of the Chief Government Statistician Zanzibar (OCGS) or the Ministry of Health. Official region and national figures are those published in the TDHS-MIS 2022 final report. Every estimate should be read with its confidence interval and reliability class.

Data. Tanzania Demographic and Health Survey and Malaria Indicator Survey 2022 (The DHS Program); 2022 Population and Housing Census 10% sample and administrative boundaries (NBS); Google Open Buildings 2.5D Temporal, Landsat 8 NDVI and Google Satellite Embedding (Google Earth Engine). Maps show the 2022 census boundaries and do not imply any judgement on the legal status of any territory.

Contact. Questions about this report, the estimates or the underlying files can be sent to SpacePilots at info@spacepilots.io.

Preview edition. This is an abridged edition of the full report. It shows the approach, the main findings and the quality of the estimates. Council, district and ward estimates with their confidence intervals, the full set of maps and the technical appendices are in the full report and data package (Chapter 8).

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Executive summary

More than a third of Tanzanian women aged 20–49 are overweight or obese, and the share varies more than fourfold between councils: from 15% in Ngorongoro District Council to 66% in Tanga City Council. Overweight is above all an urban condition: it affects about half of women in city and municipal councils and under a third in most district councils. One in eight women has hypertension, from 4% to 24% across councils.

4.2 million
women age 20–49 overweight or obese in 2022, 1.7 million of them obese

1.5 million
women age 20–49 with hypertension, 13% of all women in this age group

194 of 195
council estimates of overweight or obesity meet the 20% CV reliability threshold

2.6×
more accurate than council estimates of overweight from the survey alone, in an independent test

Purpose. The 2022 Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) gives reliable figures on women's nutritional status and blood pressure for the nation and its 31 regions, but health promotion, screening for diabetes and hypertension and other responses to the rise of non-communicable diseases are planned and delivered by councils. With about 25 measured women per council, direct survey estimates for councils are too imprecise to use (median CV 36% for overweight and 59% for hypertension). This report fills that gap.

Approach. The estimates come from two models of individual women, fitted to the women measured in the survey and applied to every woman aged 20–49 in the 2022 census. A model of body mass index (BMI) gives overweight and obesity together, so the two are always consistent; a model of hypertension status, based on the survey's blood pressure readings, gives hypertension for the same women. Both use each woman's age and her household's characteristics, the density of buildings where she lives and region effects. In an independent test on half of the survey, both models were as accurate as the best of three alternatives, including a satellite-based machine-learning model, and far more accurate than direct survey estimates.

KEY FINDINGS

- **An urban pattern.** Overweight and obesity average 51% in the six city councils, 49% in municipal councils, 41% in town councils and 30% in district councils. Tanga CC (66%), Mbeya CC (61%) and Kusini DC in Zanzibar (59%) are highest; 20 councils exceed 50%.
- **Lowest around Lake Victoria.** The lowest levels, about 20%, are in rural councils of Mwanza, Mara, Geita and Shinyanga, and in Ngorongoro DC (15%).
- **Numbers follow population.** The five Dar es Salaam councils alone hold 17% of all overweight or obese women; the 40 councils with the most hold half of them. Dar es Salaam CC (210,000), Temeke MC (179,000), Ubungo MC (156,000) and Kinondoni MC (142,000) have the largest numbers.
- **Obesity.** 14% of women are obese (BMI 30 or above), 1.7 million in all. Obesity exceeds 20% in 36 councils and reaches 38% in Tanga CC.
- **Hypertension.** 13% of women aged 20–49, 1.5 million, have hypertension. It exceeds 15% in 63 councils and is highest in Kibaha TC (24%), Morogoro MC, Namtumbo DC and Bagamoyo DC. It rises with overweight across councils (correlation 0.52), but rural councils in Ruvuma, Kagera and Morogoro combine high hypertension with moderate overweight.
- **Consistency with official figures.** Aggregated to region, the council estimates agree with the survey's region figures within sampling error in 30 of 31 regions for overweight and in all 31 for hypertension.

Reliability. 194 of 195 council estimates of overweight or obesity meet the standard reliability threshold (CV below 20%) and the other is “use with caution”; the median 95% confidence interval is ±8 points. In an independent test, the typical estimation error was about 38% of that of council estimates from the survey alone, a 2.6-fold improvement in accuracy. Hypertension is rarer and harder to predict: 58 council estimates are reliable, 125 “use with caution” and 12 unreliable, with a median interval of ±5 points. The hypertension estimates are best used to identify groups of councils rather than to rank individual councils.

Recommendations

1. Use the council estimates to prioritize councils for prevention and screening of diet-related non-communicable diseases, and to size programmes by the number of women affected, always with their confidence intervals.
2. Start with the 50 councils where both the rate and the number of overweight or obese women are above the national midpoint: all six city councils, most municipalities and populous district councils in Mbeya, Kilimanjaro, Iringa and Pwani. Together they hold half of all overweight or obese women (Section 4.5).
3. Plan blood pressure screening with the hypertension estimates rather than the overweight estimates alone: the two overlap but differ, notably in rural Ruvuma, Kagera and Morogoro (Section 4.3).
4. Use ward figures for allocation only with great caution; they are experimental.

Abbreviations

Abbreviation	Meaning
BMI	Body mass index: weight in kilograms divided by the square of height in metres (kg/m²)
CI	Confidence interval
CV	Coefficient of variation (standard error divided by the estimate)
DBP, SBP	Diastolic and systolic blood pressure
DC, TC, MC, CC	District, Town, Municipal and City Council
EBP	Empirical best predictor
FH	Fay–Herriot (area-level) model
LGA	Local government authority
mmHg	Millimetres of mercury (unit of blood pressure)
MSE, RMSE	Mean squared error, root mean squared error
ML	Machine learning
NBS	National Bureau of Statistics
NCD	Non-communicable disease
OCGS	Office of the Chief Government Statistician, Zanzibar
PHC	Population and Housing Census
pp	Percentage points
REML	Restricted maximum likelihood
SAE	Small area estimation
SE	Standard error
TDHS-MIS	Tanzania Demographic and Health Survey and Malaria Indicator Survey

Names of the estimation methods

Name used	Method
Unit-level model (headline)	Model of each woman's BMI (for overweight and obesity) or hypertension status from her own and her household's characteristics, applied to every census woman; an empirical best predictor (Sections 3.4–3.7)
ML-grid (alternative)	Machine-learning model (gradient boosting) of survey-cluster outcomes on satellite features and council census characteristics, predicted on a ~500 m grid (Section 3.8)
FH-census+geo (alternative)	Area-level Fay–Herriot model with census and satellite covariates (Section 3.8)
ML-unit (alternative)	Woman-level machine-learning model applied to census women (Section 3.8)
Direct estimate	Survey-weighted estimate from the TDHS-MIS women in the area alone

1 Introduction

This report estimates overweight, obesity and hypertension among women aged 20–49 for every council in Tanzania in 2022, the level at which health services are planned and budgeted.

1.1 Background

Overweight and obesity are rising fast in sub-Saharan Africa, especially among women and in towns and cities (Popkin, Corvalan and Grummer-Strawn 2020; NCD Risk Factor Collaboration 2024). Excess body weight is the main modifiable risk factor for type 2 diabetes and hypertension, raises the risks of pregnancy complications, and adds to the burden on primary health care. An adult is overweight when her body mass index (BMI) is 25 kg/m² or above and obese when it is 30 or above (WHO 2000). Hypertension is itself a leading risk factor for stroke, heart disease and kidney failure, and often goes undiagnosed: in the 2022 TDHS-MIS, 11% of women aged 15–49 had high blood pressure at the time of the survey, but only 6% had ever been told by a health provider that their blood pressure was high (Ministry of Health et al. 2023).

The 2022 TDHS-MIS found that 36% of women aged 20–49 in Tanzania were overweight or obese, and 14% obese (Ministry of Health et al. 2023), with large differences between regions: from 18% in Rukwa and Mara to 54% in Dar es Salaam and Kusini Unguja. The survey is designed to give reliable estimates for the nation and its 31 regions. It is not designed for councils, the local government authorities that plan and deliver prevention, screening and care.

1.2 The problem: too few women per council

The survey weighed and measured 5,335 women aged 20–49 with a valid BMI (excluding pregnant women and women who gave birth in the preceding two months), a median of 23 per council, and measured the blood pressure of 6,013. Six councils had no sampled households at all. Direct survey estimates for councils are therefore very imprecise, with a median coefficient of variation of 36% for overweight and 59% for hypertension; 80% of councils would fail the usual reliability threshold of 20% even for overweight.

Small area estimation (SAE) addresses this by borrowing strength from auxiliary data that cover every area, here the 2022 Population and Housing Census and satellite imagery (Rao and Molina 2015; Corral et al. 2022). The census and survey were carried out only months apart, which makes them well suited to being combined.

1.3 Previous small area estimates of overweight and obesity

Small area estimates of obesity are produced routinely in the United States and Australia, and the main approaches all have counterparts among the estimators compared here. In the United States, the PLACES programme of the Centers for Disease Control and Prevention publishes model-based estimates of adult obesity for every county, city and census tract, combining a multilevel model of the national health survey with census population counts (multilevel regression and poststratification; Zhang et al. 2014; CDC 2025). Area-level Fay–Herriot models have also been used for county overweight (Xie, Raghunathan and Lepkowski 2007). In Australia, the Australian Bureau of Statistics models adult obesity, measured from height and weight in its National Health Survey, for small areas, and the estimates are published for every local government area in the Social Health Atlas of Australia (PHIDU 2026). In England, Amies-Cull et al. (2022) fitted a model of BMI to the Health Survey for England and applied it to census microdata to estimate BMI for every local authority, the same logic as the unit-level model in this report. In sub-Saharan Africa, Mutai (2022) estimated overweight for Kenya's 47 counties with an arcsine Fay–Herriot model combining a health survey and the census, the same specification as the Fay–Herriot alternative here, and found the same urban gradient; Ozodiegwu et al. (2020) used Bayesian hierarchical models of DHS data to map women's overweight in second-level administrative units of seven countries, including Tanzania. Satellite imagery has also been shown to predict neighbourhood obesity well, because the built environment reflects urban lifestyles (Maharana and Nsoesie 2018), the idea behind the ML-grid alternative.

This report builds on that work in two ways. It compares these approaches, together with machine-learning alternatives, on independent survey data before choosing one. And it links the survey to a census taken in the same year and to satellite features corrected for the displacement of survey locations.

1.4 Objectives

1. Estimate the prevalence of overweight or obesity, of obesity and of hypertension, and the number of women affected, for all 195 councils and 150 districts, with standard errors, confidence intervals and reliability classes.
2. Test the accuracy of the chosen method against statistical and machine-learning alternatives on independent data.
3. Check that the estimates are consistent with the TDHS-MIS region figures.
4. Assess whether ward estimates can be supported.

1.5 Structure of the report

Chapter 2 describes the data and Chapter 3 the methodology. Chapter 4 presents the results for overweight, obesity and hypertension, and Chapter 5 their quality and validation. Chapter 6 discusses limitations and Chapter 7 concludes. Chapter 8 describes the full report and data package, including the technical appendices that are not part of this preview edition.

2 Data

The estimates combine a national household survey, the 2022 census and satellite-derived data. All refer to 2022 or close to it: the survey (February–July 2022) and the census (August 2022) were carried out only months apart.

2.1 Data sources

Tanzania Demographic and Health Survey and Malaria Indicator Survey 2022 (TDHS-MIS). A nationally representative household survey conducted by the Ministries of Health of Tanzania Mainland and Zanzibar, NBS and OCGS, with technical assistance from ICF through The DHS Program (Ministry of Health et al. 2023). Women in a half-sample of households were weighed, measured and had their blood pressure taken. The data were downloaded from The DHS Program website after registration and approval of a data request. Four files were used: the **women's (IR) recode file**, with each woman's height, weight, blood pressure readings, use of blood pressure medication, pregnancy status, education, marital status and births; the **household member (PR) file**, for the characteristics of her household; the **GPS data set (TZGE81FL)**, with displaced cluster locations; and the **geospatial covariates data set (TZGC81FL)**, used for comparison only.

Population and Housing Census 2022, 10% sample (PHC). A 10 percent sample of all household and person records from the 2022 census, conducted by NBS and OCGS in August 2022. The household file and three person files were used: demographics, education and fertility (women aged 10 and over). Together they cover 1.42 million households and 1,160,665 women aged 20–49 in regular households, representing about 11.6 million women.

PHC 2022 administrative boundaries. The post-census geodatabase published by NBS, with the boundaries of 31 regions, 150 districts, 195 councils and 4,339 wards used in the 2022 census.

Satellite-derived data. Three products were exported from Google Earth Engine: Google Open Buildings 2.5D Temporal (building presence, counts and heights, 2018–2023, aggregated to ~500 m); a Landsat 8 vegetation index (NDVI) composite for 2022 at 100 m; and the Google Satellite Embedding 2024, a 64-band representation of the land surface at 100 m, of which the first 15 principal components were used.

Table 1. Summary of data sources

Data set	Producer	Obtained from	Content used	Role in the analysis
TDHS-MIS 2022, IR and PR files	MoH, NBS, OCGS, ICF	The DHS Program (registration required)	5,335 women 20–49 with valid BMI and 6,013 with valid blood pressure; 628 clusters	Outcomes; woman and household covariates
TDHS-MIS 2022, GPS file (TZGE81FL)	The DHS Program	The DHS Program	Displaced cluster coordinates	Linking clusters to councils; satellite features
TDHS-MIS 2022, covariates (TZGC81FL)	The DHS Program	The DHS Program	Raster summaries at cluster points	Comparison only
PHC 2022, 10% sample	NBS, OCGS	NBS	1.42 million households; 1,160,665 women 20–49 (11.6 million nationally) with education, marital status and births	Covariates; prediction population; population counts
PHC 2022 boundaries	NBS	NBS	31 regions, 150 districts, 195 councils, 4,339 wards	Estimation units; maps
Open Buildings 2.5D Temporal	Google Research	Google Earth Engine	Building density, height, built-up fraction (~500 m)	Covariates; settlement weights
Landsat 8 NDVI, 2022	USGS/NASA	Google Earth Engine	Vegetation index (100 m)	Covariate
Satellite Embedding, 2024	Google DeepMind	Google Earth Engine	64-band land-surface representation (100 m)	Covariates (15 principal components)

2.2 Survey outcomes

Overweight and obesity follow the TDHS-MIS 2022 final report (Table 11.15.1): women aged 20–49 with a valid height and weight, excluding pregnant women and women who gave birth in the preceding two months. Women aged 15–19 are assessed in DHS-8 against the WHO BMI-for-age reference and are not part of these indicators. This processing reproduces the official figures exactly: 35.9% overweight or obese, 14.0% obese and 7.0% thin nationally, and all 31 region values to within 0.05 percentage points.

Hypertension follows Table 3.20.1 of the same report. Blood pressure was measured three times during the interview, in the same half-sample of households. A woman has hypertension if the average of her second and third readings is 140 mmHg or above (systolic) or 90 mmHg or above (diastolic), or if she is currently taking medication to lower her blood pressure. This is a statistical description of the population at one visit, not a clinical diagnosis. Processed in this way, the survey data reproduce the published prevalence among women aged 15–49 (11.1% against 11.2% published) and the published region values to within 0.1 percentage points in 27 of 31 regions (at most 1.2 points in the other four). As for the other indicators, the estimates refer to women aged 20–49, so that hypertension and overweight can be compared council by council: 13.3% of them have hypertension, more than among women 15–49 because hypertension is rare among teenagers. Pregnant women are included, as in the published indicator.

2.3 Census

The census 10% sample provides the population to which the models are applied: every woman aged 20–49 in a regular household, with her own characteristics and those of her household. Household and person records were linked for 99.998% of households, and council and ward names were matched to the 2022 boundary files for over 99.9% of records. The 10% sample is spatially proportional at council level, so counts multiplied by 10 give population totals; all numbers of women in this report are calculated in this way.

2.4 Harmonizing survey and census variables

A model applied to census women needs covariates measured identically in survey and census. 31 woman and household variables were constructed from both questionnaires and tested for comparability against a pre-specified rule. 21 passed and enter the models at woman level, covering the woman's education, marital status and births, and her household's head's education, housing materials, water, cooking fuel, sanitation, electricity, livestock and composition. The others are used only as council averages, where definitional differences matter less. Urban residence is excluded at woman level because the survey frame uses the 2012 urban definition.

2.5 Survey cluster locations

To protect respondents' confidentiality, DHS moves the published location of each survey cluster at random, by up to 2 km in urban and 5 km in rural areas (10 km for 1% of rural clusters), within the cluster's district (Burgert et al. 2013). Assignment of clusters to councils is therefore reliable for practical purposes, but assignment to wards is not. Satellite data read at the published point may describe the wrong place, so 1,000 possible true locations were simulated for each cluster under the displacement rules, weighted by the number of buildings, and the satellite values were averaged over them.

3 Methodology

All headline estimates come from one framework: models of individual women, fitted to the survey and applied to every woman in the census. One model of BMI gives overweight and obesity; a second gives hypertension. Three alternative estimators were compared with them on independent data.

3.1 Overview of the estimators

Small area estimators differ in the level at which the model is fitted (woman, survey cluster or council), the data used to fit it and to predict from it, and whether a council's own survey data enter its estimate. The headline estimates use unit-level models: they learn how a woman's BMI, or her chance of having hypertension, depends on her age, her household and the place she lives, and apply that relationship to all 11.6 million women aged 20–49 counted in the census. Because overweight and obesity are both read off the same modelled BMI of each woman, they are consistent by construction, and because hypertension is predicted for the same census women, the two outcomes can be compared council by council. Three alternatives, all fitted to the same survey women and the same census and satellite data, were built to test the headline models (Table 2).

Table 2. The estimators compared

Estimator	Model level	Fitted to	Predicts for	Council's own survey data	Uncertainty
Unit-level model of BMI (headline: overweight, obesity)	**Woman**	**5,335 survey women: age, 21 woman and household variables, local satellite context, region**	**All 1,160,665 sampled census women 20–49 (representing 11.6 million), averaged by area**	**Through a council random effect**	**Semi-parametric bootstrap, 200 replicates**
Unit-level logistic model (headline: hypertension)	**Woman**	**6,013 survey women: the same variables**	**The same census women**	**Through a council random effect**	**Parametric bootstrap, 200 replicates**
ML-grid	Survey cluster	628 cluster outcomes: 79 satellite and council census features; gradient boosting	1.63 million populated ~500 m grid cells, weighted by women 20–49	No (prediction only)	Cluster bootstrap
FH-census+geo	Council	189 council direct estimates; census and satellite covariates	195 councils	Weighted average of direct and model prediction	Parametric bootstrap
ML-unit	Woman	Survey women: 102 woman, household and council features; gradient boosting	All census women 20–49	No (prediction only)	Cluster bootstrap
Direct estimate	—	Survey women in the council only	189 councils with survey data	Only source	Design-based, smoothed

FH = Fay–Herriot area-level model; ML = machine learning. Sections 3.3–3.8 describe each estimator.

3.2 How the data are used

The survey supplies the outcomes and the relationships the models learn; the census supplies the population and area-level information for every council; the satellite data add information on settlement, building height and land cover that neither survey nor census measures and that is closely tied to urban lifestyles. The full report sets out which pieces of each source enter which estimator.

3.3 Direct estimates

Direct estimates use only the survey women in each area: survey-weighted means, with variances linearized by cluster within the 61 sampling strata. With one to three clusters in most councils, direct variances are unstable, so they were smoothed with a generalized variance function: the pooled design effect × $p(1-p) / n_{\text{eff}}$, where p is the region prevalence and n_{eff} the council's effective sample size.

3.4 Unit-level model of BMI

Specification. The logarithm of the BMI of woman i in survey cluster c of council d is modelled as

$$\log \text{BMI}_{icd} = x'_{icd}\beta + u_d + v_c + e_{icd}, \quad u_d \sim \text{N}(0, \sigma^2_u), \quad v_c \sim \text{N}(0, \sigma^2_v)$$

the nested-error model of Battese, Harter and Fuller (1988) with a cluster level. BMI is modelled on the log scale because it is right-skewed. The covariates are the woman's age group, the 21 harmonized woman and household variables, two satellite features of the place where she lives, selected by LASSO (Tibshirani 1996), and region fixed effects. Council census and satellite variables were offered as context, but none added information beyond the woman, household and local variables.

Residual distribution. Overweight and obesity depend on the whole distribution of BMI, not just its mean. Log-BMI residuals are heteroscedastic: their spread grows with the predicted BMI. The model therefore uses the empirical residuals of women with similar predicted BMI, which reproduces observed overweight within the survey (36.4% against 35.9%).

3.5 Unit-level model of hypertension

Hypertension is a yes/no outcome that depends on the tail of the blood pressure distribution, so it is modelled directly with a logistic model with a council random effect:

$$\text{logit Pr}(\text{hypertension}_{id}) = x'_{id}\beta + u_d, \quad u_d \sim \text{N}(0, \sigma^2_u)$$

The covariates are the same kinds as for BMI: the woman's age group, the 21 harmonized woman and household variables, local building density, one council satellite feature and region effects. Age is by far the strongest predictor: the odds of hypertension are about ten times as high at age 45–49 as at 20–24. The model was fitted by maximizing the Laplace approximation of the likelihood. A model of continuous blood pressure, with hypertension read off its residual distribution as for BMI, was tried first but under-predicted hypertension where blood pressure is more dispersed, in Dar es Salaam and Zanzibar.

3.6 From model to area estimates

Both models are applied to every woman aged 20–49 in the census sample (1,139 to 41,161 sampled women per council, median 5,014, representing about 11,400 to 411,600 women). For each census woman the BMI model gives the probability that her log BMI exceeds log 25 (overweight) and log 30 (obesity), given her prediction and the remaining uncertainty about her council's effect; the hypertension model gives her probability of hypertension in the same way. Area estimates average these probabilities over the census women of the area, and the number of women affected is the sum of the probabilities, multiplied by 10 for the 10% sample.

3.7 Uncertainty

The uncertainty of the estimates is measured by bootstrap (González-Manteiga et al. 2008; Molina and Rao 2010): synthetic census populations and survey samples are generated from the fitted model, the model is re-estimated on each synthetic survey, and the squared differences between the re-estimated and the synthetic true values are averaged over 200 replicates. For BMI the residuals are drawn from the bin of each woman's true mean (semi-parametric bootstrap); for hypertension the outcomes are drawn from the fitted probabilities (parametric bootstrap). The resulting mean squared error covers both the uncertainty of the estimated model and the variation that the model does not explain.

95% confidence intervals for prevalences are computed on the logit scale. Reliability classes follow common statistical-office practice: **reliable** (CV below 20%), **use with caution** (CV 20–33%) and **unreliable** (CV above 33%).

3.8 Alternative estimators

FH-census+geo is an area-level model of council direct estimates (Fay and Herriot 1979): the estimate is a weighted average of the direct estimate and a regression prediction from council covariates, with more weight on the prediction the noisier the direct estimate. Prevalences are modelled on the arcsine square-root scale, with at most ten covariates selected by LASSO from census and satellite council variables. Census covariates explain 87% of the true between-council variation in overweight, but none was selected for hypertension.

ML-grid learns from places. Its target is the survey-weighted share of overweight (or obese, or hypertensive) women in each of the 628 survey clusters. Its features are satellite features at the cluster's location, corrected for the displacement of cluster coordinates, and census variables of the cluster's council. The model predicts every populated ~500 m grid cell, and cell predictions are averaged with weights equal to their estimated number of women aged 20–49.

ML-unit is trained on the survey women with woman, household and council features and applied to every census woman.

The machine-learning models use gradient boosting (LightGBM; Ke et al. 2017), chosen over regularized linear models by council-grouped cross-validation. Their cluster bootstrap measures estimation variance only, not model error, so their uncertainty is not comparable with that of the headline models; their estimates are delivered without standard errors.

3.9 Choice of the headline models

All estimators were compared in a split-sample test on independent data (Section 5.3). The unit-level models were statistically tied with the most accurate method for both outcomes: ML-grid had a marginally smaller error for overweight or obesity (paired $t = -0.3$) and for hypertension ($t = -1.0$), differences well within chance. FH-census+geo was tied for overweight but less accurate for hypertension, and ML-unit was less accurate for both. Among the equally accurate methods, the unit-level models were chosen for four reasons:

- **Coherence.** Overweight and obesity come from one model of BMI, so obesity can never exceed overweight and the two rank councils consistently.
- **One framework for all outcomes.** Overweight and hypertension are predicted for the same census women with the same kinds of covariates, which makes them directly comparable.
- **Uncertainty.** The bootstrap of a statistical model measures the full error of each estimate. The machine-learning alternatives have no such model, and their uncertainty would have to be calibrated to the test results with additional assumptions.
- **Transparency.** Each covariate's effect can be read from the coefficients.

The alternative estimates are delivered with the data for sensitivity analysis.

3.10 Benchmarking and indicators reported for regions only

The headline estimates are not rescaled to match the TDHS-MIS region figures; region gaps are within sampling error, and rescaling would import the region figures' sampling error into every council. A benchmarked version is included in the data package.

Thinness (BMI below 18.5, 7% of women) is reported for regions only. None of the census and satellite variables helped predict differences in thinness between councils (the covariate selection kept none), so council estimates would be little better than the imprecise direct estimates.

4 Results

Overweight and obesity among women are highest in the cities and municipalities, on the coast, in Zanzibar and in Kilimanjaro and Mbeya, and lowest in rural councils around Lake Victoria. Hypertension follows overweight only in part. Most affected women live in a few large urban councils.

> **Preview edition.** This chapter shows summary maps in four classes and the priority councils in rank order. The full report has detailed maps of every indicator, ranked tables with estimates and confidence intervals, and the data package gives every council, district and ward estimate (Chapter 8).

4.1 Overweight and obesity by council

The share of women aged 20–49 who are overweight or obese ranges from 15.4% (Ngorongoro DC) to 66.4% (Tanga CC). 20 councils exceed 50%, 58 exceed 40% and 38 are below 25% (Figure 1, Table 3). The highest levels are in city, municipal and town councils (Tanga CC, Mbeya CC, Moshi MC, Korogwe TC, Kibaha TC, Mtwara Mikindani MC, Arusha CC), in Zanzibar (Kusini DC, Kati TC) and in Kyela DC in Mbeya. The lowest are in rural councils of Mwanza (Kwimba DC, Buchosa DC, Misungwi DC), Mara (Serengeti DC, Tarime DC), Geita (Nyang'hwale DC) and Shinyanga (Ushetu DC), and in Ngorongoro DC. On average, overweight affects 51% of women in the six city councils, 49% in municipal councils, 41% in town councils and 30% in district councils. Within a region, councils typically differ by about 18 percentage points, and by more than 30 in Arusha and Tanga, where a city sits among rural district councils.

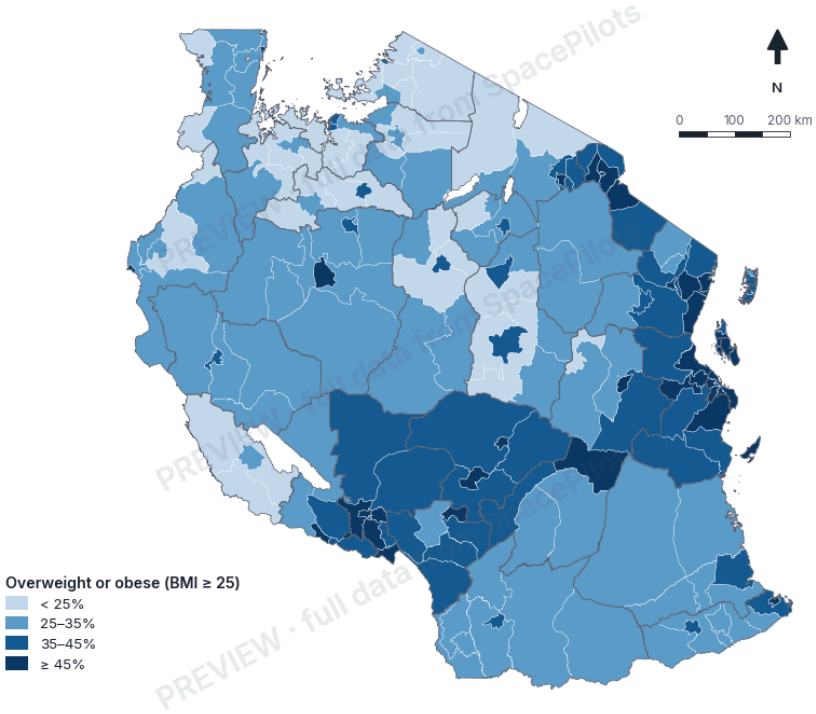


Figure 1. More than half of women are overweight or obese in 20 councils, mostly cities, municipalities and towns. Prevalence of overweight or obesity (BMI 25 or above) among women age 20–49 by council, 2022, in four classes.

Source: SpacePilots small area estimates (unit-level model) from TDHS-MIS 2022, PHC 2022 and satellite data. Grey lines are region boundaries. The data package gives each council's estimate with its standard error, 95% confidence interval, CV and reliability class.

Table 3. Priority councils: the ten with the highest prevalence of overweight or obesity among women and the ten with the most overweight or obese women, 2022

Rank	Highest prevalence	Most women affected
1	**Tanga CC (Tanga)**	Dar es Salaam CC (Dar es Salaam)
2	**Mbeya CC (Mbeya)**	Temeke MC (Dar es Salaam)
3	Kusini DC (Kusini Unguja)	Ubungo MC (Dar es Salaam)
4	Moshi MC (Kilimanjaro)	Kinondoni MC (Dar es Salaam)
5	Kyela DC (Mbeya)	Arusha CC (Arusha)
6	Korogwe TC (Tanga)	**Mbeya CC (Mbeya)**
7	Kati TC (Kusini Unguja)	Dodoma CC (Dodoma)
8	Kibaha TC (Pwani)	**Tanga CC (Tanga)**
9	Mtwara Mikindani MC (Mtwara)	Morogoro MC (Morogoro)
10	Bagamoyo DC (Pwani)	Mkuranga DC (Pwani)

Councils in rank order. Bold: in the top ten on both measures. Estimates, confidence intervals and the ranking of all 195 councils are in the data package.

Obesity. Nationally 14.4% of women aged 20–49 are obese, about 1.7 million women. Council estimates range from 3.7% (Ngorongoro DC) to 37.8% (Tanga CC) and follow the same geography as overweight (correlation 0.99). The five highest are Tanga CC, Mbeya CC, Kusini DC, Kyela DC and Moshi MC; 36 councils exceed 20%.

4.2 Hypertension by council

About one in eight women aged 20–49 has hypertension: 12.7% when the council estimates are aggregated, against 13.3% in the survey. Council estimates range from 4.0% (Serengeti DC) to 23.8% (Kibaha TC) (Figure 2). 63 councils exceed 15% and 79 are below 10%. The highest levels are on the coast (Kibaha TC, Bagamoyo DC and Kibaha DC in Pwani; Tanga CC), in Morogoro MC, in Ruvuma (Namtumbo DC, Mbinga TC, Songea DC, Tunduru DC), in Bukoba MC and in Kati TC in Zanzibar. The lowest are in Mara (Serengeti, Tarime, Butiama and Rorya), Katavi (Mlele DC, Mpimbwe DC) and Chunya DC. Hypertension is more common in urban councils, but the gradient is shallower than for overweight: it averages 16% in municipal councils, 14% in city and town councils and 11% in district councils.

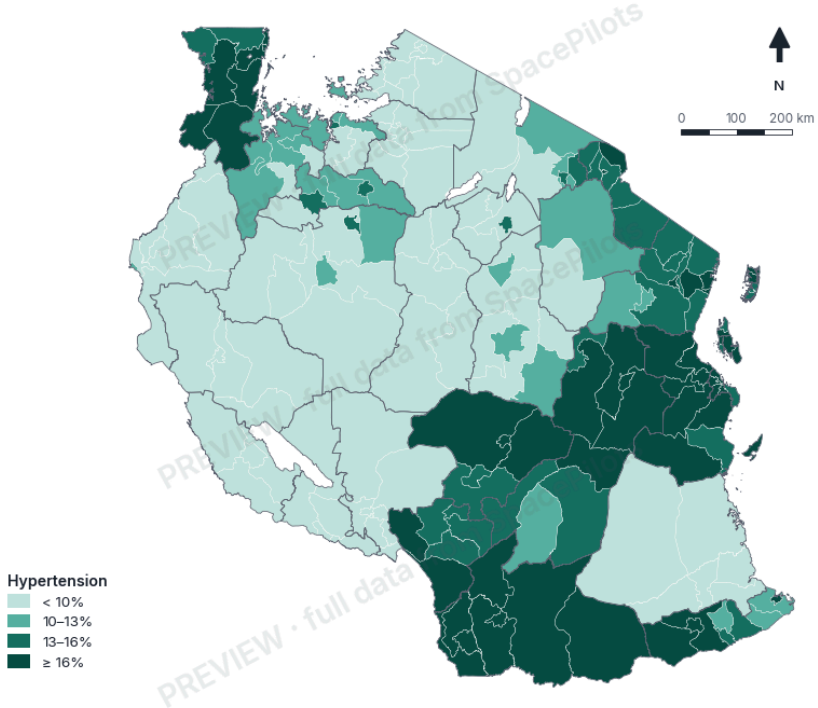


Figure 2. Hypertension is most common on the coast, in Ruvuma and in several towns; lowest in Mara and Katavi. Prevalence of hypertension among women age 20–49 by council, 2022, in four classes.

Hypertension: blood pressure 140/90 mmHg or above, or taking antihypertensive medication. Source: SpacePilots small area estimates (unit-level logistic model) from TDHS-MIS 2022, PHC 2022 and satellite data.

4.3 Hypertension and overweight

Councils with more overweight women also tend to have more hypertension (correlation 0.52 across councils; Figure 3), and 73 councils are above the median on both. Tanga CC, Kibaha TC, Bagamoyo DC and Morogoro MC are high on both. The relationship is far from one to one, however. Rural councils in Ruvuma (Namtumbo, Songea, Tunduru, Mbinga and Nyasa), Kagera (Karagwe, Muleba), Morogoro (Kilosa, Mvomero), Njombe (Makete) and Mtwara (Nanyumbu) have hypertension of 18–22% with overweight of only 26–35%. Conversely, Mbeya CC has the second highest overweight (61%) but hypertension of only 8%, in line with the low hypertension the survey found in Mbeya region. A map of overweight is therefore not a substitute for a map of hypertension when planning screening.

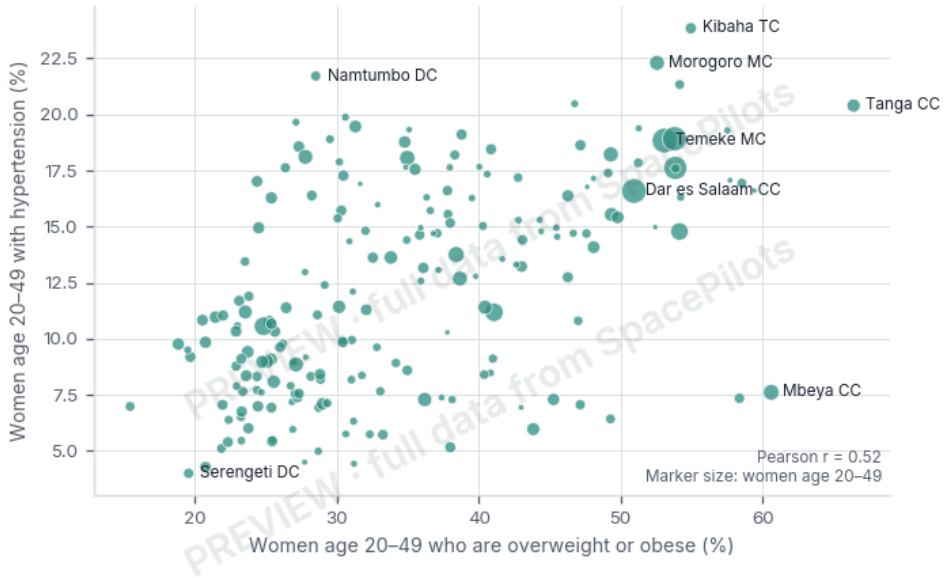


Figure 3. Hypertension rises with overweight, but some rural councils combine high hypertension with moderate overweight. Prevalence of hypertension and of overweight or obesity among women age 20–49, by council, 2022.

Source: SpacePilots small area estimates (unit-level models), 195 councils.

4.4 Number of women affected

An estimated 4.2 million of Tanzania's 11.6 million women aged 20–49 are overweight or obese, and 1.5 million have hypertension. The number in a council depends mainly on its population (correlation 0.95 for overweight), and less on its prevalence (rank correlation 0.36). The five Dar es Salaam councils hold 17% of all overweight or obese women and 17% of women with hypertension, and for both outcomes the 40 councils with the largest numbers hold half of all affected women (Figure 4). Dar es Salaam CC, Temeke MC, Ubungo MC and Kinondoni MC have the largest numbers on both measures. Two councils, Tanga CC and Mbeya CC, are among the ten highest on both prevalence and numbers of overweight or obese women (Table 3).

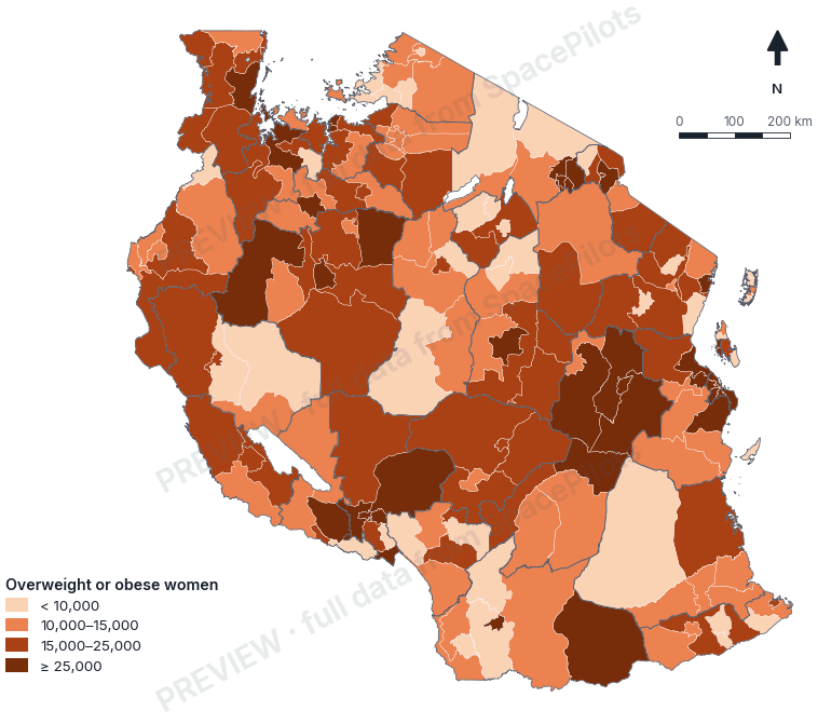


Figure 4. Half of the 4.2 million overweight or obese women live in 40 of the 195 councils. Estimated number of overweight or obese women age 20–49 by council, 2022, in four classes.

Number = prevalence × women age 20–49 from the 2022 census (10% sample × 10). The data package gives each council's number with its confidence interval.

4.5 Prevalence and numbers compared

Figure 5 plots each council's prevalence of overweight or obesity against its number of affected women. Dividing councils at the national prevalence (36.3%) and the median number of affected women (about 15,000) gives four groups:

- **Higher prevalence, more women affected** (50 councils, 51% of all affected women): all six city councils, 19 of the 23 municipal councils, six town councils and populous district councils in Mbeya, Kilimanjaro, Iringa, Pwani, Arusha and Tanga. These are priorities on either criterion.
- **Higher prevalence, fewer women affected** (27 councils, 7%): smaller towns and municipalities such as Lindi MC, Mafinga TC and Kibaha DC.
- **Lower prevalence, more women affected** (47 councils, 24%): large rural district councils such as Geita DC, Kilosa DC, Mbozi DC and Muleba DC, where prevalence is moderate but the population is large.
- **Lower prevalence, fewer women affected** (71 councils, 18%).

Prevalence and numbers largely point to the same places: the highest-prevalence fifth of councils holds 41% of affected women, because the most affected councils are also among the most populous.



Figure 5. The cities combine the highest rates with the largest numbers. Prevalence of overweight or obesity and number of women affected by council, 2022.

Dotted lines: national prevalence from the council estimates (36.3%) and median number per council. Grey lines: equal numbers of women age 20–49. Vertical axis on a log scale. Source: SpacePilots small area estimates (unit-level model).

4.6 Districts and regions

District estimates come from the same models. For overweight or obesity, Tanga, Kusini and Kyela districts are highest and Ngorongoro, Kwimba and Nyang'hwale lowest. For hypertension, Kibaha and Namtumbo are highest and Serengeti and Tarime lowest.

Table 4 compares the survey's region figures with the council estimates aggregated to region. For overweight or obesity the two agree within two standard errors in 30 of the 31 regions and differ by 3.3 points on average. The exception is Mara, where the survey's 18.0% is the second lowest in Tanzania and the council estimates aggregate to 24.4%; with 31 regions, one such deviation is expected by chance. For hypertension all 31 regions agree within two standard errors. Nationally the council estimates total 36.3% for overweight or obesity (survey 35.9%) and 12.7% for hypertension (survey 13.3%).

Table 4. Region estimates: survey figures and aggregated council estimates, women age 20–49, 2022

Region	Overweight, survey (95% CI)	Overweight, councils	Obese, survey	Thin, survey	Hypertension, survey (95% CI)	Hypertension, councils
Kusini Unguja	53.9% (±9.1)	58.1%	31.1%	5.1%	18.5% (±6.3)	18.4%
Dar es Salaam	53.9% (±4.9)	52.5%	28.1%	5.2%	18.7% (±2.8)	17.7%
Mbeya	52.8% (±15.1)	49.8%	26.1%	2.2%	7.7% (±4.5)	6.8%
Kilimanjaro	48.5% (±11.0)	47.4%	17.6%	8.9%	17.1% (±5.5)	15.4%
Mjini Magharibi	47.2% (±6.3)	48.9%	24.8%	11.7%	15.3% (±4.6)	16.3%
Njombe	44.4% (±9.3)	38.6%	11.6%	3.0%	17.9% (±5.1)	15.5%
Kaskazini Pemba	44.1% (±7.2)	37.7%	18.6%	7.1%	20.2% (±5.8)	17.7%
Kusini Pemba	43.8% (±8.1)	40.9%	17.4%	10.7%	14.1% (±5.6)	14.7%
Iringa	42.7% (±6.7)	42.0%	14.7%	1.3%	15.5% (±6.0)	16.6%
Pwani	42.3% (±11.2)	46.9%	23.4%	7.8%	21.5% (±8.4)	19.2%
Arusha	42.2% (±10.7)	39.1%	17.8%	9.6%	11.6% (±5.2)	11.9%
Kaskazini Unguja	40.8% (±10.2)	44.9%	19.1%	14.0%	16.5% (±6.6)	16.0%
Tanga	40.2% (±11.5)	42.4%	14.2%	12.6%	14.3% (±6.5)	15.4%
Morogoro	40.0% (±9.7)	38.0%	11.4%	6.4%	17.1% (±6.8)	17.7%
Mwanza	36.6% (±10.6)	27.8%	10.1%	6.5%	11.0% (±5.7)	11.4%
Singida	35.8% (±9.1)	27.5%	12.3%	12.1%	7.2% (±5.4)	7.0%
Songwe	34.4% (±8.6)	37.0%	10.5%	4.0%	9.0% (±8.3)	6.9%

Region	Overweight, survey (95% CI)	Overweight, councils	Obese, survey	Thin, survey	Hypertension, survey (95% CI)	Hypertension, councils
Mtwara	33.7% (±7.8)	34.3%	13.3%	7.1%	16.7% (±7.3)	15.4%
Ruvuma	33.3% (±12.3)	31.3%	9.3%	4.8%	20.8% (±6.7)	19.2%
Lindi	32.1% (±11.2)	31.6%	9.2%	7.2%	6.6% (±4.6)	7.1%
Shinyanga	31.9% (±8.2)	26.4%	8.6%	5.8%	15.3% (±7.5)	12.0%
Dodoma	31.1% (±12.3)	30.1%	14.9%	6.7%	10.5% (±6.3)	10.0%
Kigoma	29.0% (±9.6)	30.4%	15.0%	6.8%	9.0% (±4.5)	8.0%
Manyara	28.9% (±10.4)	28.1%	11.5%	12.6%	9.6% (±4.8)	9.4%
Katavi	28.6% (±8.9)	30.1%	8.7%	10.4%	5.9% (±5.3)	6.1%
Kagera	28.4% (±14.6)	27.9%	8.7%	5.5%	21.5% (±9.2)	17.1%
Tabora	27.4% (±8.2)	30.3%	10.0%	7.7%	9.7% (±2.8)	9.8%
Simiyu	24.9% (±6.7)	27.3%	8.0%	4.1%	9.4% (±4.5)	7.8%
Geita	21.4% (±11.2)	25.1%	7.8%	8.4%	11.4% (±4.5)	10.5%
Mara	18.0% (±6.1)	24.4%	5.5%	7.2%	5.7% (±4.3)	5.3%
Rukwa	17.6% (±9.7)	26.4%	3.8%	3.8%	9.5% (±4.2)	8.5%

Regions sorted by TDHS-MIS prevalence of overweight or obesity. Survey: overweight (or obese), obesity and thinness are the published TDHS-MIS figures; hypertension is computed from the survey for women 20–49 (the published figure covers women 15–49). Councils: council estimates aggregated to region. 95% CI shown as ± percentage points. Thinness (BMI below 18.5) is not estimated below region level.

4.7 Ward estimates (experimental)

> **Experimental.** Ward results show where to look more closely within a council. They should only be used for allocating resources with great caution.

The unit-level models, averaged over each ward's census women, give estimates for 4,336 wards. Overweight or obesity ranges from 11% to 74% of women. 586 wards exceed 50%, most of them in Dar es Salaam, Mbeya, Mjini Magharibi, Tanga and Kusini Unguja; 401 are below 20%, mainly in Mwanza, Mara, Geita, Arusha and Shinyanga. Within a council, ward estimates typically span about 20 percentage points, and up to 33–36 points where a town is surrounded by rural wards, as in Simanjiro DC, Dodoma CC, Arusha DC, Morogoro MC and Handeni TC. Hypertension ranges from 3% to 31% of women but varies much less within councils (median span 5 points). Ward variation comes only from the characteristics of the ward's census women and households and its building density; the models have no ward-level effect, and survey data cannot be assigned to wards because of the displacement of cluster locations. The median model-based CV of the ward estimates of overweight is 17%, but it does not capture ward-specific deviations and should be read as a lower bound. Figure 6 shows one region, Arusha, as a sample.

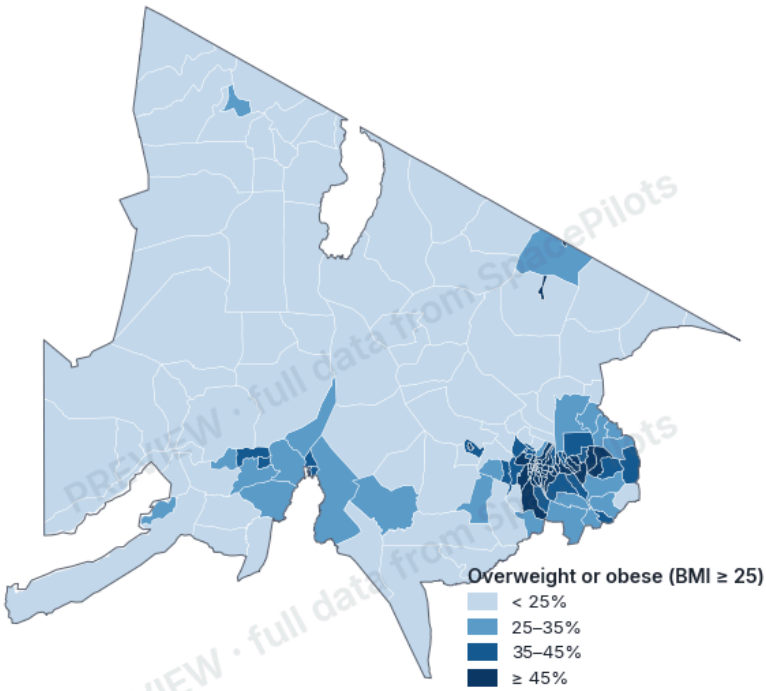


Figure 6. Sample of the ward-level product: Arusha region. Experimental estimates of overweight or obesity among women by ward, 2022, in four classes.
Unit-level model averaged over the census women of each ward. The data package covers all 4,336 wards with estimates.

5 Quality and validation

194 of 195 council estimates of overweight or obesity are reliable. Hypertension estimates are less precise but still far better than the survey alone. In an independent test the headline models were as accurate as the best alternative.

5.1 Precision

Table 5. Precision of the estimates by level and indicator

Level	Indicator	Median CV	Median 95% CI width	Reliable	Use with caution	Unreliable
Council (195)	Overweight or obesity	12%	15.3 pp	194	1	0
Council (195)	Obesity	20%	9.2 pp	103	92	0
Council (195)	Hypertension	23%	10.6 pp	58	125	12
District (150)	Overweight or obesity	12%	14.6 pp	149	1	0
District (150)	Obesity	19%	8.4 pp	89	61	0
District (150)	Hypertension	22%	10.2 pp	59	85	6

Reliable: CV below 20%; use with caution: CV 20–33%; unreliable: CV above 33%. pp = percentage points.

Overweight or obesity. 194 council estimates are reliable and one, Ngorongoro DC (CV 23%), is “use with caution”; the median CV is 12% and the median 95% confidence interval ±7.7 points. Ngorongoro has the lowest prevalence and sparse, dispersed settlement. The six councils without survey data (Korogwe TC, Pangani DC, Bagamoyo DC, Rufiji DC, Nanyamba TC and Nzega TC) have CVs of 9–13%, similar to other councils, because the council effect is small and the estimates rest mainly on the census.

Obesity. Obesity is rarer, so its CVs are larger: 103 council estimates are reliable and 92 “use with caution”; none is unreliable.

Hypertension. Hypertension is rarer and harder to predict than overweight. The median council CV is 23% and the median 95% confidence interval ±5.3 points: 58 council estimates are reliable, 125 “use with caution” and 12 unreliable. The unreliable estimates are all low-prevalence councils, most of them in Mara (Serengeti DC, Tarime DC and TC, Bunda DC and TC, Butiama DC), Songwe (Tunduma TC, Songwe DC, Ileje DC) and Katavi (Mlele DC). The estimates are best used to identify groups of councils with high and low hypertension; councils whose intervals overlap should not be ranked against each other.

5.2 Gain over direct survey estimates

The model-based estimates reduce the median CV from 36% to 12% for overweight or obesity and from 59% to 23% for hypertension. Without them, 80% of councils would fail the reliability threshold even for overweight. The model estimates replace noisy council direct estimates with predictions supported by the census and satellite data.

5.3 Independent accuracy test

Model-based standard errors depend on assumptions, so accuracy was also measured directly. In each of 20 replicates, the survey clusters in each council with at least two clusters (169 councils) were split at random into two halves. Every method was refitted on one half and its council estimates compared with direct estimates from the other, independent half; that half's sampling variance was subtracted to give each method's mean squared error (Figure 7, Table 6).

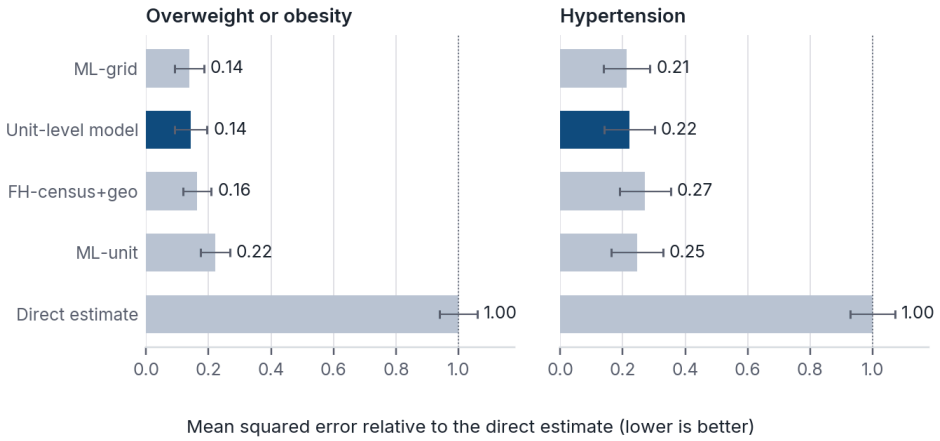


Figure 7. **The headline models cut the mean squared error of direct estimates by 86% for overweight and 78% for hypertension.** Split-sample validation error for council overweight or obesity and hypertension, by method.

Bars: mean squared error relative to the direct estimate, 20 replicates; whiskers: 95% intervals. Dark bars: headline model.

Table 6. Split-sample validation results, council level (estimates fitted on half the survey)

Method	Overweight: RMSE (pp)	Overweight: MSE vs direct	Overweight: t	Hypertension: RMSE (pp)	Hypertension: MSE vs direct	Hypertension: t
Unit-level model (headline)	**5.5**	**0.14**	**—**	**4.4**	**0.22**	**—**
ML-grid	5.4	0.14	−0.3	4.3	0.21	−1.0
FH-census+geo	5.9	0.16	1.1	4.9	0.27	2.8
ML-unit	6.8	0.22	4.3	4.7	0.25	2.1
Direct estimate	14.5	1.00	27.4	9.4	1.00	21.9

Overweight: overweight or obesity. 169 councils with at least two survey clusters, 20 replicates. MSE vs direct: mean squared error relative to the direct estimate. t: paired t-statistic against the headline unit-level model; positive t means a larger error, and |t| below 2 is a statistical tie.

For overweight or obesity, the unit-level model had a root mean squared error of 5.5 points against 14.5 for direct estimates. ML-grid (5.4) and FH-census+geo (5.9) were statistically tied with it, and ML-unit (6.8) was significantly less accurate. For hypertension, the unit-level logistic model had an error of 4.4 points against 9.4 for direct estimates; ML-grid (4.3) was tied with it, and ML-unit (4.7) and FH-census+geo (4.9) were significantly less accurate. The full report gives the validation design and replicate-level results.

5.4 Consistency with official figures

Region aggregates of the council estimates of overweight or obesity are within two standard errors of the official TDHS-MIS figure in 30 of 31 regions (Table 4), and the spread of the 31 differences (SD 0.92 standard errors) is no larger than sampling noise alone would produce. There is no sign of systematic bias at region level. For hypertension all 31 regions are within two standard errors; the spread (SD 0.41) is smaller than sampling noise alone would produce, because the logistic model's region effects tie the aggregates closely to the survey's region values. This check is therefore less informative for hypertension than for overweight.

6 Discussion and limitations

The estimates are precise enough to rank and target councils for overweight, and to identify groups of councils for hypertension. They show that overweight among women is primarily an urban phenomenon in Tanzania, but also substantial in some rural areas such as Kilimanjaro and Mbeya.

6.1 What drives the results

Women's BMI rises with age, with electricity, finished floors and being married, and falls with no schooling, cooking with firewood and crowding. Building density where a woman lives adds to these. Together they describe the urban transition: less physical work, more purchased and processed food and higher incomes. The rural councils of Kilimanjaro, Mbeya and parts of Pwani and Zanzibar are exceptions with high levels, consistent with their higher living standards and dense settlement. Hypertension is driven above all by age; household living standards have small effects, and differences between regions, which the model carries over from the survey, account for much of the variation between councils.

6.2 Comparison with the alternatives

All four model-based methods agree closely on which councils have high and low overweight (correlations 0.90–0.92 with the headline estimates). The satellite-grid model was as accurate as the unit-level model, because overweight follows the urban gradient closely and satellite imagery captures it at a fine scale; giving the unit-level model local building density and leaving out council variables that added nothing beyond the household data brought it level with ML-grid. Census council averages are also unusually strong predictors of overweight (87% of the between-council variation), so the Fay–Herriot model performs well for overweight. For hypertension, council census and satellite variables explain little, and the methods agree less (correlations 0.59–0.79 with the headline estimates). The methods that use information on individual women or local settlement, the unit-level model and ML-grid, were more accurate than the council-level Fay–Herriot model, which has to rely on council averages.

6.3 Limitations

- **Model-based estimates.** The council random effects are small, so the estimates rest mainly on the covariates and region effects. A council that is unusual in ways the census and satellite data do not capture can have a larger error than its CV suggests. The independent test is the better guide to real accuracy.
- **Region effects.** Both models include region effects estimated from the survey, so a region's survey figure, including its sampling error, influences all its councils. This explains, for example, the low hypertension estimate for Mbeya CC.
- **Pregnancy.** The overweight indicators exclude pregnant and recently delivered women; the census cannot identify them, so estimates refer to women aged 20–49 at their non-pregnant BMI.
- **Hypertension.** Blood pressure was measured at a single visit, which overstates hypertension compared with a clinical diagnosis based on repeated visits. Differences between councils are hard to predict from census and satellite data, so the hypertension estimates are less precise than those of overweight.
- **Single cross-section.** The estimates describe 2022.
- **Wards.** Ward estimates are experimental (Section 4.7).

7 Conclusions and recommendations

Council-level estimates of overweight and obesity among women can be produced with good precision, and of hypertension with moderate precision, by combining the 2022 TDHS-MIS with the 2022 census and satellite data. They show a steep urban–rural gradient that region figures only partly reveal.

7.1 Conclusions

1. Overweight or obesity affects 36% of women aged 20–49, 4.2 million women, and varies more than fourfold across councils, from 15% to 66%. 20 councils exceed 50%.
2. It is highest in cities, municipalities and towns, in Zanzibar and in Kilimanjaro and Mbeya, and lowest in rural councils around Lake Victoria. Half of all affected women live in 40 councils, 17% in Dar es Salaam alone.
3. 14% of women, 1.7 million, are obese; obesity exceeds 20% in 36 councils.
4. 13% of women aged 20–49, 1.5 million, have hypertension, from 4% to 24% across councils. It is highest on the coast, in Ruvuma and in several towns, and follows overweight only in part (correlation 0.52).
5. 194 of 195 council estimates of overweight or obesity are reliable, against 20% of councils with direct survey estimates alone.
6. The unit-level models were as accurate as the best of three alternatives in an independent test, with an estimation error about 2.6 times smaller than that of direct survey estimates for overweight and 2.1 times smaller for hypertension.
7. The estimates agree with the official region figures within sampling error.

7.2 Recommendations for users

1. **Targeting.** Prioritize cities and municipalities, where rates and numbers are both high, for prevention, nutrition counselling and screening for diabetes and hypertension.
2. **Blood pressure screening.** Use the hypertension estimates to target screening and follow-up, including in the rural councils of Ruvuma, Kagera and Morogoro, where hypertension is high although overweight is moderate.
3. **Interpretation.** Always report confidence intervals and reliability classes alongside the estimates.
4. **Official figures.** Use the TDHS-MIS figures for national and region reporting, and these estimates for comparisons below region level.

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Data sources

TDHS-MIS 2022 recode, GPS and covariate files (The DHS Program); published region values from the TDHS-MIS 2022 final report, Tables 3.20.1 and 11.15.1; PHC 2022 10% sample and boundaries (NBS); Google Open Buildings 2.5D Temporal, Landsat NDVI and Google satellite embeddings (Google Earth Engine exports).

8 The full report and data package

This preview is an abridged edition. The full report and the data package give the estimates for every area, the complete set of maps and the technical documentation needed for review.

8.1 Data package

Table 7. Contents of the data package

Component	Coverage	Contents
Council estimates	195 councils	Overweight or obesity, obesity and hypertension, each with standard error, 95% confidence interval, CV and reliability class; number of women affected; women age 20–49; survey sample sizes and direct estimates
District estimates	150 districts	The same indicators and quality measures
Region estimates	31 regions	Survey figures for overweight or obesity, obesity, thinness and hypertension, council aggregates and consistency checks
Ward estimates (experimental)	4,336 wards	Overweight or obesity, hypertension and number of women affected
Alternative estimates	Councils and districts	A version benchmarked to the region figures, and the alternative estimators for sensitivity analysis
Maps and charts	All levels	High-resolution maps of every indicator and all charts in the full report

Tables are supplied as CSV files that join to the 2022 census boundaries.

8.2 What the full report adds

- **Results.** Detailed council maps (seven classes) of overweight or obesity, obesity, hypertension, the numbers of women affected and the reliability of each estimate; ranked tables of the councils with the highest and lowest prevalence and the most women affected, with estimates, confidence intervals and numbers; the full ward map.
- **Methods.** How each data source enters each estimator; the specification, variables and coefficients of the two headline models; the specification and configuration of the alternative models.
- **Quality.** The map of reliability classes and the comparison of model and direct estimates for every council with survey data.
- **Technical appendices.** Data preparation; the headline models; the alternative models; the validation design and the development of the BMI model; agreement between models; benchmarking to region figures; and a guide to the data files and methodological choices.

For the full report and data package, contact SpacePilots at info@spacepilots.io.