

**SUPPLEMENTARY FILE 3 – DHS data weight de-normalization and pooling. GMHS 2007 and 2017**

DHS applies sample weights to adjust for disproportionate sampling and non-responders. Individual weights are “normalized” to make the total number of unweighted cases equal to the total number of weighted cases on a national level. (1) Sample weights are normalized by dividing each individual weight by the ratio of the sum of all weights to the size of the sample:

$$NSw = DSw / (\Sigma (Dsw) / Snumber)$$

NSw is the normalized sample weight

DSw is the de-normalized or original sample weight

$\Sigma (Dsw)$  is the sum of all original sample weights or the size of the reference population.

Snumber is the number of women in the sample

When pooling data from the Ghana Maternal Health Surveys (GMHS) 2007 and 2017, we decided to de-normalize sample weights prior to combining datasets, to account for the difference in population size in 2007 and 2017. To de-normalize weights, individual sample weights were divided by the sampling fraction. We calculated the sampling fraction by dividing the study sample of women aged 15 – 49 years by the total population of women aged 15 – 49 years in Ghana, for each study separately. To estimate the total number of Ghanaian women aged 15 – 49 years during the study period, we used population size data from The World Bank. The total population was multiplied with the fraction of the total population of women aged 15 – 49 years, as provided by the GMHS study reports. (2, 3) The following equation was used:

$$Sf = Ti / (Tp \times Fp)$$

Sf is the sampling fraction

Ti is the number of interviewed women aged 15-49 years in GMHS

Tp is the total de facto population of woman

Fp is the fraction of the total population of women aged 15-49 years.

In GMHS 2007, Ti was 10,370. (2) Tp was 11,385,621. (4) Fp was 45,2%. (2) This provided a Sf of 0.00201503966.

In GMHS 2017, Ti was 25,304. (3) Tp was 14,366,665. (4) Fp was 47,2%. (3) This provided a Sf of 0.00373156675.

Pooling of data from GMHS 2007 and 2017 provides a unweighted sample size of 17,138 women who had given birth. De-normalized weights of individual women were normalized once again, multiplying each individual weight by 17,138 and subsequently divided by the sum of all individual weights combined: 5,698,422.46. Applying This gave provided a normalized sample size of 17,138 women: 7,819 in 2007 and 9,319 in 2017.

[1]. Ren R. Note on DHS standard weight de-normalization. Source: <https://userforum.dhsprogram.com>. Accessed: 16-10-2022

[2]. Ghana Statistical Service (GSS), Ghana Health Service (GHS), and Macro International. 2009. Ghana Maternal Health Survey 2007. Calverton, Maryland, USA: GSS, GHS, and Macro International.

[3]. Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF. 2018. Ghana Maternal Health Survey 2017. Accra, Ghana: GSS, GHS, and ICF.

[4]. World Bank Data. Population, female - Ghana. World Development Indicators. World Bank Group. 2019. [cited 2022 17-5-2022]; Available from: <https://data.worldbank.org/indicator/SP.POP.TOTL.FE.IN?locations=GH>