

RESEARCH

Open Access



Socioeconomic disparities in Rwanda's under-5 population's growth tracking and nutrition promotion: findings from the 2019–2020 demographic and health survey

Michael Ekholuenetale¹, Osaretin Christabel Okonji², Chimezie Igwegbe Nzopotam^{3,4}, Clement Kevin Edet⁵, Anthony Ike Wegbom⁶ and Amit Arora^{7,8,9,10,11*}

Abstract

Background Regular growth monitoring can be used to evaluate young children's nutritional and physical health. While adequate evaluation of the scope and quality of nutrition interventions is necessary to increase their effectiveness, there is little research on growth monitoring coverage measurement. The purpose of this study was to investigate socioeconomic disparities in under-5 Rwandan children who participate in growth monitoring and nutrition promotion.

Methods We used data from the 2019–2020 Rwanda Demographic and Health Survey (RDHS), which included 8092 under-5 children. Percentage was employed in univariate analysis. To examine the socioeconomic inequalities, concentration indices and Lorenz curves were used in growth monitoring and nutrition promotion among under-5 children.

Results A weighted prevalence of 33.0% (95%CI: 30.6–35.6%) under-5 children growth monitoring and nutrition promotion was estimated. Growth monitoring and nutrition promotion among under-5 children had higher uptake in the most disadvantaged cohort, as the line of equality sags below the diagonal line in Lorenz curve. Overall, there was pro-poor growth monitoring and nutrition promotion among under-5 in Rwanda (Conc. Index = 0.0994; SE = 0.0111). Across the levels of child and mother's characteristics, the results show higher coverage of under-5 growth monitoring and nutrition promotion in the most socioeconomic disadvantaged cohort.

Conclusion The study found a pro-poor disparity in growth monitoring and nutrition promotion among under-5 children in Rwanda. By implication, the most disadvantaged children had a higher uptake of growth monitoring and nutrition promotion. The Rwanda government should develop policies and programmes to achieve the universal health coverage for the well-off and underserved population.

Keywords First 2000 days, Malnutrition, Stunting, Socioeconomic inequalities, Growth monitoring, Nutrition promotion

*Correspondence:

Amit Arora

a.arora@westernsydney.edu.au

Full list of author information is available at the end of the article



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Background

The United Nations International Children's Emergency Fund (UNICEF) defines growth monitoring as a monthly assessment of a child's development in terms of growth with reference to the World Health Organization (WHO) benchmark, using anthropometric indicators to detect growth dysfunction and malnutrition threshold [1, 2]. Child growth monitoring is a useful practice to evaluate the health and nutritional status of children [3]. Several indicators such as stunting, underweight, wasting, undernutrition and overweight can be measured during child growth monitoring [4]. However, none of these indicators are exactly the same. For example, stunting is not always same as undernutrition [5]. The foundational elements for healthy growth, a strong immune system and the development of the brain are all built on a child's first year of nutrition. It also helps prevent noncommunicable diseases (NCDs) linked to obesity in the future [6, 7]. Despite significant recent progress in reducing child mortality, over five million children die before age five every year, mainly as a result of inadequate infant and young child nutrition (IYCN) [8]. An alarming amount of food insecurity has resulted in 144 million stunted children and nearly half of all under-5 anaemia worldwide [9].

Undernutrition accounts for approximately 45% of deaths in under-5 children globally [10]. The majority of children's suboptimal feeding occurs in resource-constrained settings. Furthermore, the prevalence of childhood malnutrition are rising in resource-constrained countries. For example, approximately 45.4 million children were estimated to be wasted, 38.9 million children were overweight and 149.2 million under-5 had stunted growth [11]. Children who are stunted are becoming less common across all WHO regions, except in African [11]. However, with regard to obesity, roughly half of all countries have either seen no improvement or a worsening of the situation [11].

Growth monitoring and nutrition promotion (GMNP) is a preventive strategy that advocates for appropriate and proper feeding practices for under-5 children and monitors, measures, interprets and analyses potential causes of adequate or insufficient child growth. Additionally, it encourages interaction and communication, promotes appropriate health-seeking behaviour, child's nutritional status and reduces child morbidity and mortality [1, 3, 12]. Several countries around the world have very low rates of attendance and promotion toward GMNP and many caregivers have poor understanding of the growth charts. The GMNP programme implementation and subsequent changes in care practices have not been extensively studied in many countries [13, 14]. It is challenging to carry out effective growth monitoring activities and community involvement are frequently ignored when

determining whether to include growth monitoring in national surveillance programmes [14].

The Sustainable Development Goals (SDGs), specifically those targeting to eradicate poverty in all of its forms globally (SDG 1), eradicate hunger, achieve food security, improve nutrition and promote sustainable agriculture (SDG 2), as well as ensuring healthy lives and promoting health and quality of life for all at all ages (SDG 3), must be attained adequately by reducing childhood malnutrition [15, 16]. Several countries have agreed to the global targets to reduce stunting (chronic undernutrition) by 40% by 2025 and to keep the prevalence of wasting (acute undernourishment) in children under the age of five to less than 5% [17]. The practices of GMNP among key population such as under-5 children are key in achieving these SDGs. Taking into account global efforts to improve infant and child feeding practices through the International Code of Marketing of Breast milk Substitutes, the promotion of proper nutrition, including breastfeeding [18], the Global Strategy for Infant and Young Child Feeding [19] and The Code, the baby friendly hospital initiative (BFHI) [20], are essential part of children's growth mechanisms.

The UNICEF conceptual framework on nutrition, posited that psychosocial stimulation, nutrition and health are the critical components for improving and enhancing children's quality of life. This implies that appropriate feeding practices must be accelerated to achieve better growth and development [17]. Due to extreme financial uncertainty that resulted in Rwanda's genocide nearly three decades ago, malnutrition has been said to be more prevalent [21]. Several progressive policies outlined in Rwanda's Vision 2020 plan have reportedly been put into practice to support the country's economic recovery [22]. In turn, this has led to significant improvements in health of the populace across a range of population health metrics [23]. For instance, between 2000 and 2015, the rates of newborn and under-5 mortality decreased, while the rate of vaccinations significantly increased [24]. This progress might be attributed to advancements from citizens' participation to improve the healthcare system, such as the implementation of the neighbourhood health insurance policy to enhance economic access to care and the development of a strong health-care workforce.

Research to investigate socioeconomic inequalities in GMNP among Rwanda's under-5 population have, to the best of our knowledge, received little or no attention in spite of several studies conducted thus far on the subject matter [23–25]. The dearth of under-5 GMNP data in Rwanda is a critical gap that our study is set out to fill. Therefore, we would like to answer the question of who, between the disadvantaged or well-off are more likely to uptake under-5 GMNP. The findings from this study add to knowledge base or literature and useful for

stakeholders in healthcare system to develop viable interventions and adopt relevant policies. The magnitude of these inequalities is investigated as it helps to reduce inequalities in service uptake. The objective of this study was to evaluate socioeconomic inequalities in under-5 GMNP in Rwanda.

Methods

Data source

Data from children's survey questionnaire from the 2019–20 Rwanda Demographic and Health Survey (RDHS) was analysed in this study. A total of 8,092 under-5 children were included in the sample. The 1992, 2000, 2005, 2010, and 2014–15 surveys were followed by the 2019–20 RDHS, which was the sixth round. The survey was conducted by the Rwandan National Institute of Statistics with funding from the Inner-City Fund (ICF) and the Ministry of Health. The survey was conducted from November 2019 to July 2020. Data collection was suspended for about three months (March–June) due to the effects of the lockdown that followed the coronavirus pandemic in 2020 [26]. Information relevant to monitoring population health was gathered by the RDHS on topics including nutrition among others [26]. A previous study has reported the methodology of RDHS [27].

Sampling design

An entire nation-wide sampling frame of enumeration areas (EAs) was provided by the National Institute of Statistics, the RDHS's implementing organization. The first step in the 2-stage stratified cluster sampling approach was to select clusters made up of EAs. There were 500 clusters, with 388 in rural and 112 in urban areas. In the second phase, systematic household sampling was carried out. A household listing was done in each of the selected EAs from June to August 2019, and the households that were surveyed were selected at random. With an average of 26 households per cluster across the nation, there were 13,000 households.

Selection and measurement of variables

Outcome

Participation in growth monitoring and nutrition promotion services was estimated in this study and measured dichotomously as “1” if “yes” and “0” otherwise. This outcome variable has also been measured by a previous study [25].

Explanatory variables

There are several variables that were included in this study, thus: age of mother, family mobility, mother's education, mother's marital status, currently pregnant, currently breastfeeding, mother's employment status, child's age (months), sex of child, preceding birth interval,

place of childbirth, geographical region. In addition, low birthweight (<2.5 kg) compared to normal birthweight (≥ 2.5 kg); male versus female household head; household wealth is divided into five quintiles, from poorest to richest; urban versus rural status of residence; households with 1–4, 5–6, and 7+ members; Furthermore, items such as rural residence, lowest household wealth level, mothers with no formal education and not working were used to compute the socioeconomically disadvantaged level. To separate the overall assigned scores to low, moderate, and high, the standardized z-score was subjected to principal component analysis (PCA).

Concentration curves and indices

The concentration index is a widely used method for analyzing health inequities. The indices and curves investigate the presence of health inequalities. They do not, however, quantify the degree of health disparities. The Erreygers normalised concentration indices [28] were used in this study to assess the degree of socioeconomic disparities in tracking growth and promoting nutrition. Among the several indices that may have been employed, the Erreygers was chosen because of its simplicity and capacity to be decomposable.

The concentration index can be computed making use of the 'convenient covariance' as shown below:

$$CI = \frac{2}{\hat{y}} COV(y_i, R_i) \quad (1)$$

Where: y_i is the health variable.

\hat{y} is the mean of y_i .

R_i is the fractional rank of the i th individual.

COV symbolizes the covariance.

Concentration indices are calculated by dividing the area between the concentration curve and the line of equality (the 45-degree line) by two [29]. A concentration curve on the 45° line indicates that there is no health inequality. The concentration curve's distance from the line of equality (45° line) indicates the magnitude of the health inequality. The wider the distance between the concentration curve and the line of equality, the higher the level of health inequality. This study chose to employ the normalized formulae because it is suggested that normalizing the health concentration index formula assures that the boundaries issue for a binary Cardinal Health variable is resolved. The Erreygers normalized index ($E(c)$) is denoted as:

$$E_c = \frac{4\hat{y}}{y^{max} - y^{min}} CI \quad (2)$$

In the case of binary variables, $y^{max} - y^{min}$ represents the range of the health variable, which is 'one'. As both

corrected concentration indices are extensively used in the health literature, the current investigation concentrated on the Erreygers normalised index.

Decomposing the erreygers normalised concentration index

The Erreygers Normalised concentration index can be decomposed to calculate the contributions of maternal health indicator determinants [30, 31]. Health inequalities were decomposed into the contributions of several explanatory factors, with each contribution being the product of health elasticity. Given a linear relationship between individual health (y_i) and a collection of k explanatory variables, y_i will be as follows:

$$y_i = a + \sum_k \beta_k X_{ki} + \varepsilon_i \tag{3}$$

Wagstaff et al. [31] demonstrated that the concentration index for any health measure that has a linear relationship with a set of k exploratory variables may be divided as follows:

$$CI = \sum_k \left(\frac{\beta_k \dot{X}_k}{\hat{y}} \right) CI_k + \frac{GCI_\varepsilon}{\hat{y}} \tag{4}$$

Where: β_k is the partial.

\hat{y} is the mean of the health variable.

\dot{X}_k is the mean of X_k .

CI_k denotes the concentration index of x_k against income.

GCI_ε is the generalised concentration for the error term.

To decompose the Erreygers concentration index, we modified Eq. (4) as shown below [32]:

$$E_c = 4 \left[\sum_k (\beta_k \dot{X}_k) CI_k + GCI_\varepsilon \right] \tag{5}$$

Statistical analysis

The survey module ('svy') command was used to adjust for sampling design. Percentage was used in the univariate analysis. To examine socioeconomic inequalities, concentration indices and curves were used in tracking growth and promoting nutrition. The concentration index value is positive when growth monitoring and nutrition promotion were higher in high socioeconomic disadvantaged children. The converse is however true when the concentration index value is negative [4, 33]. The level of statistical significance was set at $p < 0.05$. For data analysis, Stata version 14 (StataCorp., College Station, TX, USA) was utilized.

Ethical consideration

For the purposes of this study, identifier information was removed from a secondary dataset that was publicly accessible. In order to get the respondent's informed consent, RDHS adhered to a recognised ethical procedure. Since the authors were granted approval for this study dataset, no additional participants' consent was required. You can find information about DHS ethical standards here: <http://goo.gl/ny8T6X>.

Results

A weighted prevalence of 33.0% (95%CI: 30.6-35.6%) under-5 GMNP was estimated. It follows that in 2019–20, approximately two-thirds of Rwandan under-5 children did not utilize growth monitoring and nutrition promotion services.

Table 1 shows the distribution of under-5 GMNP across child and mother characteristics. Based on the results, the most disadvantaged children had higher prevalence in the uptake of under-5 GMNP in Rwanda. The prevalence of under-5 GMNP increased as children get older. Similarly, normal birthweight (≥ 2.5 kg) under-5, female folks, those delivered at health facility, native, those having mothers with no formal education, who listen to radio or currently in union, covered by health insurance or from households with male headship, resident in South, West region or rural areas, reported higher prevalence of under-5 GMNP respectively.

The socioeconomic inequalities for under-5 GMNP in Rwanda are depicted in Fig. 1. How far the curves deviate from the line of equality indicates whether there are greater inequalities and to what extent. Figure 1 demonstrates that the most disadvantaged cohort had higher uptake of under-5 GMNP, as the line of equality sags below the diagonal line.

Table 2 showed results of socioeconomic disadvantaged inequalities for under-5 GMNP. Overall, there was poorer under-5 GMNP (Conc. Index=0.0994; SE=0.0111). Across the levels of child and mother's characteristics, the results show higher coverage of under-5 GMNP in the most socioeconomic disadvantaged cohort. In addition, there was difference in the concentration indices across the levels of the following variables: family motility ($p=0.005$), mothers who watch TV ($p=0.001$), sex of household headship ($p=0.021$) and geographical region ($p=0.005$) respectively.

Table 3 shows Erreygers concentration (E_c) indices decomposed in order to determine the contribution (Contri) of under-5 GMNP in Rwanda. Place of residence (Contri: 82.3650%, E_c : 0.0633), mother internet use (Contri: 18.4502%, E_c : -0.5608), household wealth (Contri: 15.7047%, E_c : -0.0749), family motility (Contri: 10.8086%, E_c : 0.0280), mother's employment (Contri: 6.1858%, E_c : 0.0686) and mother's education (Contri: 5.2514%,

Table 1 Distribution of under-5 GMNP in Rwanda across socioeconomic disadvantaged level

Variable	n (%)	Socioeconomic disadvantaged level		
		Least disadvantaged (n=2707)	Moderate disadvantaged (n=2703)	Most disadvantaged (n=2682)
Child's age (months)				
0–11	1618 (20.0)	22.0	31.2	34.7
12–23	1633 (20.2)	25.0	40.2	43.5
24–35	1643 (20.3)	26.0	43.9	38.8
36–47	1633 (20.2)	26.4	39.2	39.4
48–59	1565 (19.3)	30.6	40.2	46.1
P		0.240	0.016*	0.018*
Preceding birth interval				
< 24 months	867 (10.7)	25.2	38.9	40.0
24–48 months	3618 (44.7)	27.4	40.6	43.8
> 48 months	1527 (18.9)	27.1	37.9	38.6
First born	2080 (25.7)	19.9	30.7	32.9
P		0.028*	0.012*	0.005*
Birthweight (kg)				
< 2.5	541 (7.1)	28.3	34.7	31.9
≥ 2.5 (normal weight)	7118 (92.9)	24.7	38.2	41.0
P		0.441	0.499	0.087
Sex of child				
Male	4095 (50.6)	23.7	35.6	39.4
Female	3997 (49.4)	25.6	39.1	40.7
P		0.411	0.154	0.619
Place of delivery				
Health facility	7663 (94.7)	25.0	37.7	40.0
Home	429 (5.3)	5.3	28.1	40.0
P		0.048*	0.121	0.995
Mother's age (years)				
15–24	1287 (15.9)	24.3	27.3	31.1
25–34	3949 (48.8)	23.9	37.4	41.5
35+	2856 (35.3)	26.5	43.0	43.5
P		0.602	< 0.001*	0.001*
Family motility				
< 5 years	2791 (34.5)	20.8	26.6	37.2
5+ years (native)	5301 (65.5)	28.4	42.8	41.2
P		0.001*	< 0.001*	0.147
Mother's education				
No formal education	918 (11.3)	31.3	42.8	47.7
Primary	5277 (65.2)	26.8	37.3	39.6
Secondary+	1897 (23.4)	21.8	34.9	29.7
P		0.050	0.299	< 0.001*
Household size				
1–4	3084 (38.1)	23.2	35.9	38.1
5–6	3154 (39.0)	24.7	38.6	44.2
7+	1854 (22.9)	27.0	37.1	36.4
P		0.435	0.633	0.024*
Mother read newspaper				
Disagree	6528 (80.7)	25.1	35.3	39.7
Agree	1564 (19.3)	23.8	47.2	42.2
P		0.595	< 0.001*	0.492
Mother listen to radio				
Disagree	1935 (23.9)	23.1	33.6	35.4

Table 1 (continued)

Variable	n (%)	Socioeconomic disadvantaged level		
		Least disadvantaged (n = 2707)	Moderate disadvantaged (n = 2703)	Most disadvantaged (n = 2682)
Agree	6157 (76.1)	25.0	38.5	42.1
P		0.545	0.098	0.012*
Mother watch tv				
Disagree	4946 (61.1)	28.3	33.0	39.8
Agree	3146 (38.9)	21.7	45.5	40.6
P		0.003*	< 0.001*	0.758
Mother surf internet				
Disagree	7431 (91.8)	27.4	37.6	40.2
Agree	661 (8.2)	15.0	25.7	23.1
P		< 0.001*	0.152	0.210
Health insurance coverage				
Disagree	1523 (18.8)	17.9	28.2	31.6
Agree	6569 (81.2)	25.9	39.1	42.3
P		0.010*	0.001*	< 0.001*
Mother's marital status				
Single	719 (8.9)	16.4	23.3	28.7
Currently in union/living with a man	6734 (83.2)	25.9	39.5	41.2
Formerly in union	639 (7.9)	19.1	30.8	34.3
P		0.030*	< 0.001*	0.033*
Mother currently working				
Disagree	2009 (24.8)	25.5	31.6	36.5
Agree	6083 (75.2)	24.1	39.1	40.8
P		0.510	0.010*	0.185
Sex of household head				
Male	6257 (77.3)	26.6	38.2	40.5
Female	1835 (22.7)	18.8	34.0	37.8
P		0.003*	0.167	0.428
Household wealth index				
Poorest	2100 (26.0)	24.5	34.9	38.7
Poorer	1666 (20.6)	27.0	38.4	44.6
Middle	1568 (19.4)	26.9	38.7	40.1
Richer	1443 (18.8)	27.8	39.9	40.2
Richest	1315 (16.3)	18.8	34.4	30.6
P		0.039*	0.550	0.093
Geographical region				
Kigali	948 (11.7)	13.7	27.5	0.0
South	1853 (22.9)	28.1	44.0	44.7
West	2069 (25.6)	42.9	46.8	49.3
North	1282 (15.8)	27.1	44.4	37.1
East	1940 (24.0)	14.7	17.2	27.5
P		< 0.001*	< 0.001*	< 0.001*
Place of residence				
Urban	1702 (21.0)	19.4	27.1	-
Rural	6390 (79.0)	31.3	37.7	40.0
P		< 0.001*	0.099	-
Total estimate	8092 (100.0)	24.7	37.3	40.0

* Significant at $p < 0.05$

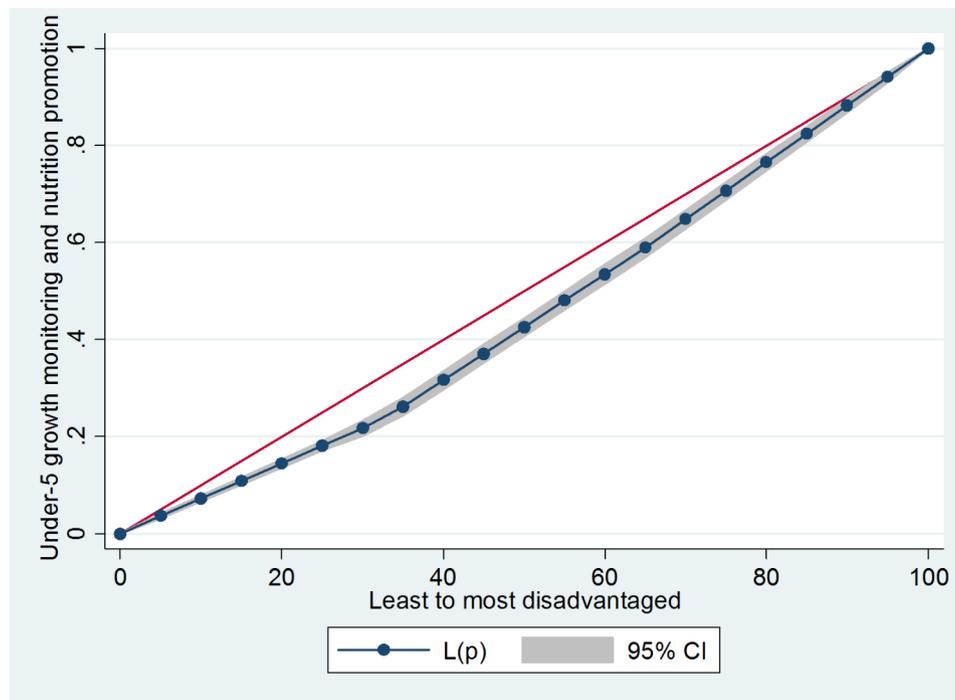


Fig. 1 Lorenz curve for under-5 GMNP by socioeconomic disadvantaged level

E_c : -0.1009) were positive contributors of under-5 GMNP. On the other hand, geographical region (Contri: -22.8640%, E_c : 0.0610), mother watch tv (Contri: -7.3178%, E_c : -0.1587) and mother listen to radio (Contri: -6.3425%, E_c : -0.0522) were negative contributors to under-5 GMNP.

Discussion

This is among the foremost studies in Rwanda to examine socioeconomic inequalities in under-5 GMNP. Similar to a previous research, the uptake of under-5 GMNP is low [25]. In addition, we found pro-poor GMNP among under-5 population. The key finding indicated that the most disadvantaged children had higher uptake of under-5 GMNP in Rwanda. This could be as a result of social and economic changes in resource-constrained settings which have experienced age-long developmental, epidemiological and demographic catastrophe. The socioeconomic distribution of health outcomes in several countries, has shifted in a way that has led to global health inequalities [34]. Notably, children aged 48–59 months that are most socioeconomically disadvantaged had greater uptake of under-5 GMNP, when compared with other age groups. This is in line with a recent study [25]. On the other hand, previous studies conducted in Ethiopia found children between 12 and 24 months to be more likely to utilize childhood GMNP services [12] [35]. Those studies however covered under 24 months old. It is well known that children from families with low socioeconomic status, have greater need for healthcare

services. The poor health conditions of under-privileged and vulnerable children requires improved health management and maintenance [36]. The higher uptake of under-5 GMNP reported among the socioeconomically disadvantaged population reflects the higher probability of older children experiencing greater food insecurity and could be malnourished.

This paper is first to explore socioeconomic inequalities in the uptake of under-5 GMNP using concentration index and Lorenz curves. We found differences in concentration indices across the levels of certain variables, such as family motility, mothers who watch TV, sex of household headship and geographical region respectively. We found considerable inequalities related to years lived in an area of residence. The degree of inequality in under-5 GMNP was wider for children who live in an area for less than five years, when compared with the native. This corroborates with a recent study from Rwanda that found that children from families who are native residents have higher uptake of under-5 GMNP [25]. A possible explanation could be that native residents may likely be more aware of the availability of under-5 GMNP services, than the non-natives. It is also possible that indigenous residents have better geographic access to these services.

In addition, the differences in regional coverage could be attributed to diverse interventions related to under-5 GMNP which may have been executed in various regions and in varied capacity or scale. A recent study found that the uptake of under-5 GMNP was higher in the southern,

Table 2 Socioeconomic inequalities in under-5 GMNP

Variable	Concentration Index	Standard Error	P
Child's age (months)			0.864
0–11	0.0993*	0.0213	
12–23	0.1113*	0.0179	
24–35	0.0775	0.0429	
36–47	0.0785*	0.0310	
48–59	0.0829*	0.0280	
Preceding birth interval			0.797
< 24 months	0.0919*	0.0329	
24–48 months	0.0908*	0.0152	
> 48 months	0.0766*	0.0274	
First born	0.1104*	0.0248	
Birthweight (kg)			0.083
< 2.5	0.0253	0.0481	
≥ 2.5 (normal weight)	0.1057*	0.0117	
Sex of child			0.800
Male	0.1027*	0.0160	
Female	0.0970*	0.0155	
Place of delivery			0.489
Health facility	0.0988*	0.0114	
Home	0.1379*	0.0466	
Mother's age (years)			0.117
15–24	0.0553	0.0297	
25–34	0.1173*	0.0158	
35+	0.0929*	0.0180	
Family motility			0.005*
< 5 years	0.1291*	0.0214	
5 + years (native)	0.0630*	0.0128	
Mother's education			0.526
No formal education	0.0474	0.0241	
Primary	0.0731*	0.0136	
Secondary+	0.0937*	0.0249	
Household size			0.083
1–4	0.1030*	0.0195	
5–6	0.1212*	0.0169	
7+	0.0583*	0.0225	
Mother read newspaper			0.081
Disagree	0.0924*	0.0124	
Agree	0.1417*	0.0241	
Mother listen to radio			0.086
Disagree	0.0675*	0.0236	
Agree	0.1126*	0.0125	
Mother watch tv			0.001*
Disagree	0.0720*	0.0140	
Agree	0.1503*	0.0177	
Mother surf internet			0.915
Disagree	0.0743*	0.0112	
Agree	0.0679	0.0392	
Health insurance coverage			0.814
Disagree	0.1093*	0.0316	
Agree	0.1023*	0.0118	
Mother's marital status			0.876
Single	0.1168*	0.0528	
Currently in union/living with a man	0.0956*	0.0116	

Table 2 (continued)

Variable	Concentration Index	Standard Error	P
Formerly in union	0.1012*	0.0500	
Mother currently working			0.617
Disagree	0.0795*	0.0226	
Agree	0.0918*	0.0126	
Sex of household head			0.021*
Male	0.0855*	0.0121	
Female	0.1493*	0.0273	
Household wealth index			0.592
Poorest	0.0775*	0.0212	
Poorer	0.1000*	0.0224	
Middle	0.0810*	0.0248	
Richer	0.0844*	0.0252	
Richest	0.1313*	0.0323	
Geographical region			0.005*
Kigali	0.0563	0.0339	
South	0.0720*	0.0199	
West	0.0294	0.0164	
North	0.0406	0.0272	
East	0.1417*	0.0325	
Place of residence			0.725
Urban	0.0242	0.0168	
Rural	0.0405*	0.0114	
Total	0.0994	0.0111	<0.001*

* Significant at $p < 0.05$; p = comparing concentration indices across the levels of a variable

western and northern regions, when compared with children from Kigali [25]. Another study conducted in Rwanda have reported similar findings [37]. This disparities in the uptake of under-5 GMNP across regions could be that children who reside in the geographical regions with lower uptake, may be unaware of the services available or unable to attend the sessions due to economic or transportation challenges. Since this survey was conducted during the Coronavirus pandemic, it is possible that the uptake may have been disrupted by the pandemic, especially that some regions may have served as the epicenter of COVID-19. Thus indicating that more of this intervention is needed in these regions by promoting the coverage and supporting caregivers to present their children as when scheduled.

We found that the uptake of under-5 GMNP was significantly higher among children from mothers who watch TV, when compared with those from mothers do not watch TV. It could be that mothers who watch TV are more aware and enlightened about under-5 GMNP, than mothers who do not watch TV. It is known that mother's exposure to mass media play an important role in enhancing health services uptake. Mothers who are expose to mass media are better informed about programmes that promote the health children as well as know about healthcare initiatives [34] [38].

The sex of household headship influenced the uptake of under-5 GMNP. We found that children from male

headed household had higher uptake of under-5 GMNP. Conversely, the degree of inequality in under-5 GMNP was wider among children from female headed household, when compared with those from male headed households. This is in contrast with a recent study conducted in Rwanda that did not find any association between under-5 GMNP and sex of household head [25]. Women's empowerment is still required to improve health services uptake in a patriarchal society. Women could have lower levels of education, less access to employment and consequently become socioeconomically disadvantaged [39]. Policies and strategies need to be design and implemented to empower women and increase their socioeconomic development.

We conducted further analysis to decompose selected child and mother's characteristics related to under-5 GMNP. Based on our findings, place of residence was the largest contributor to inequality, contributing about 82.4% of inequality to the uptake of under-5 GMNP. Other important contributors to inequality included mother's internet use, household wealth, family motility, mother's employment and education. Certainly, these variables have been identified as significant factors to consider in designing polices to increase under-5 GMNP in resource-constrained settings such as Rwanda.

The findings from our study would play a vital role in shaping nutrition policies for under-5 children. These could be used in evidence-based policy formulation and

Table 3 Decomposition of under-5 GMNP uptake

Variable	Elasticity	Concentration Index	Absolute Contribution	% Contribution
Child's age (months)	0.0468	0.0041	0.0008	0.5590
Preceding birth interval	-0.0325	-0.0153	0.0020	1.4708
Birthweight (kg)	0.0433	-0.0015	-0.0003	-0.1927
Child's sex	0.0262	-0.0040	-0.0004	-0.3124
Place of delivery	0.0027	0.3308	0.0035	2.6097
Mother's age	0.0594	0.0041	0.0010	0.7257
Family motility	0.1309	0.0280	0.0147	10.8086
Mother's education	-0.0176	-0.1009	0.0071	5.2514
Household size	-0.0543	0.0069	-0.0015	-1.1003
Mother read newspaper	0.0100	-0.1505	-0.0060	-4.4370
Mother listen to radio	0.0412	-0.0522	-0.0086	-6.3425
Mother watch tv	0.0156	-0.1587	-0.0099	-7.3178
Mother surf internet	-0.0112	-0.5608	0.0250	18.4502
Health insurance coverage	0.0886	-0.0166	-0.0059	-4.3481
Mother's marital status	0.0344	0.0121	0.0017	1.2231
Mother's employment	0.0305	0.0686	0.0084	6.1858
Sex of household head	-0.0745	-0.0169	0.0050	3.7098
Household wealth	-0.0711	-0.0749	0.0213	15.7047
Geographical region	-0.1270	0.0610	-0.0310	-
Place of residence	0.4411	0.0633	0.1117	82.3650

implementation. We identified socioeconomic inequalities in the uptake of under-5 GMNP. Hence, policies can be tailored to address socioeconomic inequalities directly by promoting universal health coverage to reach all under-5 children in Rwanda, irrespective of their socioeconomic status. In addition, the findings can be used to design and implement effective nutrition education programmes for caregivers, parents, communities and empower local leaders to promote nutrition within their communities. These programmes can help raise

awareness about proper nutrition and child growth, as well as promote healthy feeding practices. Moreover, stakeholders in healthcare system can use the findings of our study to implement nutrition policies with built-in evaluation mechanisms to regularly assess their effectiveness. Our findings can also guide in taking a comprehensive approach to addressing the nutritional and health needs of under-5 children including the uptake of growth monitoring, as it is possible to make significant improvements in their nutritional status and overall well-being by enhancing the socioeconomic development of the country at large. Furthermore, our study has brought to limelight, using a population-based data, the coverage and inequalities in under-5 GMNP in Rwanda. It is our hope that the findings of this study will be useful to stakeholders in healthcare for designing and implementing viable programmes that will help the socioeconomically disadvantaged cohort recover from child undernutrition in near future and address the disparities in prevalence of nutritional status even with the advantaged children.

Strength and limitations

The use of recent nationally representative household survey data is a major strength of this study, and the findings are generalizable to under-5 children in Rwanda. The main outcome variable was, however, measured using self-reported data, which may have recall bias. Consequently, the uptake of under-5 GMNP may have been over- or underestimated. DHS did not obtain information on household income and expenditure. Therefore, asset-based wealth index was used in this study. In addition, variables on caregivers' attitudes toward children's health were not available because the study conducted secondary data analysis. Furthermore, because availability of under-5 GMNP sessions can affect attendance, we were unable to conduct an exhaustive assessment of this factor due to the use of secondary data, which had the flaw of not containing information on the availability of sessions for growth monitoring and nutrition promotion. Moreover, we found inadequate coverage of growth monitoring and nutrition promotion among under-five in Rwanda. As we conducted a secondary data analysis, there was no information regarding the growth monitoring system, whether it has sufficient manpower, infrastructure, standard operating procedures or demand creation strategies, which could influence the level of uptake. We relied on self-reported uptake of growth monitoring and nutrition promotion.

Conclusion

This study demonstrated a pro-poor inequality in under-5 GMNP. The study showed that the most socioeconomically disadvantaged children had higher prevalence of under-5 GMNP. The findings show that individual

socioeconomic characteristics such as place of residence, wealth status, maternal education, are contributors to improving inequality. Therefore, intervention policies should be centred on these elements to reduce the disparity in the uptake of under-5 GMNP. A further effective policy strategy for reducing socioeconomic inequalities in the practice of growth monitoring and promoting optimal nutrition could be helpful in healthcare system's collaboration with other social and development sectors.

Acknowledgements

The authors appreciate the MEASURE DHS project for the approval and access to the original data.

Authors' contributions

ME and AA contributed to the conceptualization. ME was responsible for initial manuscript preparation, study design, data analysis and wrote the results. OCO, CIN, CKE, AIW, and AA contributed to manuscript preparation, review of literature and critically reviewed the manuscript for its intellectual content. All authors read and approved the final manuscript.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

Data Availability

Data for this study were sourced from Demographic and Health surveys (DHS) and available here: <http://dhsprogram.com/data/available-datasets.cfm>.

Declarations

Ethical approval and consent to participate

This study is a secondary data analysis, which is publicly available, approval was sought from MEASURE DHS/ICF International and permission was granted for this use. The original DHS data were collected in conformity with international and national ethical guidelines. Written consent was obtained from mothers/caregivers and data were recorded anonymously at the time of data collection during the data collection. More details regarding DHS data and ethical standards are available at: <http://dhsprogram.com/data/availabledatasets.cfm>.

Consent for publication

Not applicable.

Competing interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author details

¹Department of Epidemiology and Medical Statistics, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan 200284, Nigeria

²School of Pharmacy, University of the Western Cape, Cape Town 7530, South Africa

³Department of Public Health, Center of Excellence in Reproductive Health Innovation (CERHI), College of Medical Sciences, University of Benin, Benin City 300001, Nigeria

⁴Department of Medical Biochemistry, School of Basic Medical Sciences, University of Benin, Benin City 300001, Nigeria

⁵Department of Community Medicine, College of Medical Sciences, Rivers State University, Port Harcourt 500101, Nigeria

⁶Department of Public Health Sciences, College of Medical Sciences, Rivers State University, Port Harcourt 500101, Nigeria

⁷Translational Health Research Institute, Western Sydney University, Campbelltown, NSW 2560, Australia

⁸School of Health Sciences, Western Sydney University, Penrith, NSW 2751, Australia

⁹Health Equity Laboratory, Campbelltown, NSW 2560, Australia

¹⁰Discipline of Child and Adolescent Health, The Children's Hospital at Westmead Clinical School, Faculty of Medicine and Health, The University of Sydney, Westmead, NSW 2145, Australia

¹¹Oral Health Services, Sydney Local Health District and Sydney Dental Hospital, NSW Health, Surry Hills, NSW 2010, Australia

Received: 2 June 2023 / Accepted: 1 September 2023

References

- Mangasaryan N, Arabi M, Schultink W. Revisiting the Concept of Growth Monitoring and its possible role in community-based Nutrition Programs. *Food Nutr Bull.* 2011;32:42–53. <https://doi.org/10.1177/156482651103200105>.
- Liu Q, Long Q, Garner P. Growth monitoring and promotion (GMP) for children in low and middle income countries. *Cochrane Database Syst Rev.* 2017;2017: CD010102. <https://doi.org/10.1002/14651858.CD010102.pub2>.
- Yeshaneh A, Fentahun T, Belachew T, Mohammed A, Adane D. Utilization of growth monitoring and promotion services and associated factors among children aged 0–23 months in Banja District, Northwest Ethiopia 2020: a cross-sectional study. *PLoS ONE.* 2021;16:e0259968. <https://doi.org/10.1371/journal.pone.0259968>.
- Ekholuenetale M, Tudeme G, Onikan A, Ekholuenetale CE. Socioeconomic inequalities in hidden hunger, undernutrition, and overweight among under-five children in 35 sub-saharan Africa countries. *J Egypt Public Health Assoc.* 2020;95:9. <https://doi.org/10.1186/s42506-019-0034-5>.
- Scheffler C, Hermanussen M, Bogin B, Liana DS, Taolin F, Cempaka PMVP, et al. Stunting is not a synonym of malnutrition. *Eur J Clin Nutr.* 2020;74:377–86. <https://doi.org/10.1038/s41430-019-0439-4>.
- Liu J, Raine A. Nutritional status and social behavior in preschool children: the mediating effects of neurocognitive functioning. *Matern Child Nutr.* 2016;13:e12321. <https://doi.org/10.1111/mcn.12321>.
- Khanna P, Singh TP, Kaur R, Miller J, Mejie T, Minhas S. Impact of Health Promoting Nutrition Intervention Package on Severe Malnutrition among Under-Five Children in Rural Northern India. *Curr Res Nutr Food Sci J.* 2020;8: 238–244. Available: <http://www.foodandnutritionjournal.org/volume8number1/impact-of-health-promoting-nutrition-intervention-package-on-severe-malnutrition-among-under-five-children-in-rural-northern-india/>.
- Nutrition International. Children Under Five. In: Nutrition International [Internet]. [cited 5 Aug 2023]. Available: <https://www.nutritionintl.org/our-work/who-we-help/children-under-five/>.
- Children. : improving survival and well-being. [cited 21 Nov 2022]. Available: <https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality>.
- Fact sheets - Malnutrition. [cited 21 Nov 2022]. Available: <https://www.who.int/news-room/fact-sheets/detail/malnutrition>.
- World Health Organization, Fund (UNICEF) UNC, Bank W. Levels and trends in child malnutrition: UNICEF. World Health Organization; 2021. Available: <https://apps.who.int/iris/handle/10665/341135>.
- Feleke FW, Adole AA, Bezabih AM. Utilization of growth monitoring and promotion services and associated factors among under two years of age children in Southern Ethiopia. *PLoS ONE.* 2017;12:e0177502. <https://doi.org/10.1371/journal.pone.0177502>.
- Roberfroide D, Kolsteren P, Hoerée T, Maire B. Do growth monitoring and promotion programs answer the performance criteria of a screening program? A critical analysis based on a systematic review. *Trop Med Int Health TM IH.* 2005;10:1121–33. <https://doi.org/10.1111/j.1365-3156.2005.01498.x>.
- Ashworth A, Shrimpton R, Jamil K. Growth monitoring and promotion: review of evidence of impact. *Matern Child Nutr.* 2008;4(Suppl 1):86–117. <https://doi.org/10.1111/j.1740-8709.2007.00125.x>.
- Rosa W, editor. Transforming our world: the 2030 agenda for Sustainable Development. A new era in Global Health. New York, NY: Springer Publishing Company; 2017. <https://doi.org/10.1891/9780826190123.ap02>.
- Kumar S, Kumar N, Vivekadhis S. Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs): addressing unfinished agenda and strengthening Sustainable Development and Partnership. *Indian J Community Med off Publ Indian Assoc Prev Soc Med.* 2016;41:1–4. <https://doi.org/10.4103/0970-0218.170955>.

17. World Health Organization (WHO). Indicators for Assessing Infant and Young Child Feeding Practices. Washington DC, USA, 6–8. November 2007: WHO Regional Office for the Western Pacific; 2008. Report No.: Part 1.
18. World Health Organization, editor. International code of marketing of breast-milk substitutes. Geneva: Albany, N.Y: World Health Organization ; Obtainable from WHO Publications Centre; 1981.
19. WHO. Global Strategy for Infant and Young Child Feeding. 2003 [cited 15 Feb 2019]. Available: www.enonline.net/globalstrategyycfarticle.
20. World Health Organization, UNICEF. Baby-friendly hospital initiative: revised, updated and expanded for integrated care. 2009. Available: <http://www.ncbi.nlm.nih.gov/books/NBK153471/>.
21. Implementation of Economic Development & Poverty Reduction Strategy – 2008 | National Institute of Statistics Rwanda. [cited 21 Nov 2022]. Available: <https://www.statistics.gov.rw/publication/implementation-economic-development-poverty-reduction-strategy-2008>.
22. Rwanda Vision 2020 | Green Growth Knowledge Platform. [cited 21 Nov 2022]. Available: <https://www.greengrowthknowledge.org/national-documents/rwanda-vision-2020>.
23. Farmer PE, Nutt CT, Wagner CM, Sekabaraga C, Nuthulaganti T, Weigel JL, et al. Reduced premature mortality in Rwanda: lessons from success. *BMJ*. 2013;346:f65. <https://doi.org/10.1136/bmj.f65>.
24. Binagwaho A, Rukundo A, Powers S, Donahoe KB, Agbonyitor M, Ngabo F, et al. Trends in burden and risk factors associated with childhood stunting in Rwanda from 2000 to 2015: policy and program implications. *BMC Public Health*. 2020;20:83. <https://doi.org/10.1186/s12889-020-8164-4>.
25. Ekholuenetale M, Barrow A, Wegbom AI, Arora A. Measuring the Uptake of Growth Monitoring and Nutrition Promotion among under-5 children: findings from the Rwanda Population-Based study. *Children*. 2022;9:1758. <https://doi.org/10.3390/children9111758>.
26. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF. 2021. Rwanda Demographic and Health Survey 2019-20 Final Report. Kigali, Rwanda, and Rockville, Maryland, USA: NISR and ICF. Available: <https://dhsprogram.com/pubs/pdf/FR370/FR370.pdf>.
27. Corsi DJ, Neuman M, Finlay JE, Subramanian S. Demographic and health surveys: a profile. *Int J Epidemiol*. 2012;41:1602–13. <https://doi.org/10.1093/ije/dys184>.
28. Erreygers G. Correcting the Concentration Index. *J Health Econ*. 2009;28:504–15. <https://doi.org/10.1016/j.jhealeco.2008.02.003>.
29. Kjellsson G, Gerdtham UG. On correcting the concentration index for binary variables. *J Health Econ*. 2013;32:659–70. <https://doi.org/10.1016/j.jhealeco.2012.10.012>.
30. Alaba O, Chola L. Socioeconomic inequalities in adult obesity prevalence in South Africa: a decomposition analysis. *Int J Environ Res Public Health*. 2014;11:3387–406. <https://doi.org/10.3390/ijerph110303387>.
31. Wagstaff A, Van Doorslaer E, Watanabe N. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. *J Econom*. 2003;112:207–23. [https://doi.org/10.1016/S0304-4076\(02\)00161-6](https://doi.org/10.1016/S0304-4076(02)00161-6).
32. Van de Poel E, Van Doorslaer E, O'Donnell O. Measurement of inequity in health care with heterogeneous response of use to need. *J Health Econ*. 2012;31:676–89. <https://doi.org/10.1016/j.jhealeco.2012.05.005>.
33. Uthman OA. Using extended concentration and achievement indices to study socioeconomic inequality in chronic childhood malnutrition: the case of Nigeria. *Int J Equity Health*. 2009;8:22. <https://doi.org/10.1186/1475-9276-8-22>.
34. Porwal A, Acharya R, Ashraf S, Agarwal P, Ramesh S, Khan N, et al. Socio-economic inequality in anthropometric failure among children aged under 5 years in India: evidence from the Comprehensive National Nutrition Survey 2016–18. *Int J Equity Health*. 2021;20:176. <https://doi.org/10.1186/s12939-021-01512-4>.
35. Dagne S, Aliyu J, Menber Y, Wassihun Y, Petrucka P, Fentahun N. Determinants of growth monitoring and promotion service utilization among children 0–23 months of age in northern Ethiopia: unmatched case-control study. *BMC Nutr*. 2021;7:67. <https://doi.org/10.1186/s40795-021-00470-y>.
36. Bull C, Howie P, Callander EJ. Inequities in vulnerable children's access to health services in Australia. *BMJ Glob Health*. 2022;7:e007961. <https://doi.org/10.1136/bmjgh-2021-007961>.
37. Ngirabega JD, Leonard W, Munyanshongore C& D-W. Utilization of community based growth monitoring services by eligible children in rural Rwanda. *Rwanda Med J*. 2010;68: 40–47. Available: <http://www.bioline.org.br/abstract/rw10020>.
38. Dangura D, Gebremedhin S. Dietary diversity and associated factors among children 6–23 months of age in Gorche district, Southern Ethiopia: cross-sectional study. *BMC Pediatr*. 2017;17:6. <https://doi.org/10.1186/s12887-016-0764-x>.
39. Wondimu H, Delelegn W, Dejene K. What do female-headed households' livelihood strategies in Jimma city, South west Ethiopia look like from the perspective of the sustainable livelihood approach? Serpa S, editor. *Cogent Soc Sci*. 2022;8: 2075133. <https://doi.org/10.1080/23311886.2022.2075133>.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.