BMJ Open

Socio-economic inequalities in and factors associated with minimum dietary diversity among children aged 6–23 months in South Asia: a decomposition analysis

Md Ashfikur Rahman,[1] Satyajit Kundu ,[2] Harun Or Rashid ,[1] Mortuja Mahamud Tohan ,[1] Md Akhtarul Islam[1]

To cite: Rahman MA, Kundu S, Rashid HO, *et al*. Socio-economic inequalities in and factors associated with minimum dietary diversity among children aged 6–23 months in South Asia: a decomposition analysis. *BMJ Open* 2023;**13**:e072775. doi:10.1136/bmjopen-2023-072775

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2023-072775).

Received 15 February 2023
Accepted 30 November 2023

[1]Khulna University, Khulna, Bangladesh
[2]Biochemistry and Food Analysis, Patuakhali Science and Technology University, Patuakhali, Bangladesh

Correspondence to
Mortuja Mahamud Tohan; mortuzacreations@gmail.com

ABSTRACT

Objective This study aimed to determine the factors associated with minimum dietary diversity (MDD) and estimate the socioeconomic inequalities in MDD among children from five South Asian countries.

Design Cross-sectional.

Setting The study used the most recent round of secondary databases of Demographic Health Survey data of Bangladesh (2017–2018), India (2019–2021), Maldives (2016–2017), Nepal (2018) and Pakistan (2017–2018).

Participants This study used information on MDD and other explanatory variables from a total of 136 980 (weighted) children aged 6–23 months.

Methods Multivariable logistic regression was employed to identify the factors associated with MDD and concentration index (CIX) and Lorenz curve were used to measure the socioeconomic inequalities in MDD.

Results The overall weighted prevalence of MDD in South Asia was 23.37%. The highest prevalence of MDD was found among children from Maldives (70.7%), while the lowest was in Pakistan (14.2%). Living in affluent versus poor households, having a mother who is employed versus a mother who is unemployed, exposure to various forms of media (newspapers and magazines), seeking antenatal care (ANC) more than four times compared with those who sought ANC less than four times and having children older than 4 years old are the most common significant factors associated with MDD deficiency. This study found the value of the CIX for MDD (MDD: CI=0.0352; p<0.001) among children with a higher socioeconomic status, suggesting inequality in MDD in favour of the more among well-off households.

Conclusion Inequality in the prevalence of MDD favours the affluent. Health policy and intervention design should prioritise minimising socioeconomic inequalities concerning the MDD. In addition, policy-makers should prioritise the associated factors of MDD such as education, wealth status, employment, media exposure while designing intervention or policies.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Several variables, such as ethnicity, health expenditure, household food security linked to minimum dietary diversity (MDD), were not possible to include due to missing variables and missing information in the Demographic and Health Survey (DHS) dataset.
⇒ The study used a cross-sectional design, which restricts the causative direction of the identified components.
⇒ The use of 24-hour recall data for MDD might be a recall bias problem.
⇒ We have used five nationally representative latest cross-sectional DHS datasets from five South Asian countries, which is our greatest strength.
⇒ The inclusion of variables, such as media exposure, health services us in the multivariable analysis, increases the validity of the findings.

INTRODUCTION

Appropriate implementation of infant and young child feeding (IYCF) cuts the risk of babies being malnourished, having diarrhoeal diseases, measles, respiratory infection and mental impairment.[1 2] Inadequate complementary feeding practices continue to be a severe public health concern globally. Because only one out of every six children aged6–23 months receives a minimum acceptable diet, which includes both the minimal number of meals and the diversity of the diet, putting children at risk of irreversible cognitive development and outrageously increasing the risk of stunting, wasting and underweight.[3] Nearly one-fourth of young children do not get the balanced nutrition they need to grow properly, especially in the first 1000 days, in a number of different nations.[4 5] In the early years of life, in particular, optimal IYCF practices help to assure growth and raise children's survival rates by lowering the risk of various chronic diseases and lifestyle-related illnesses.[6 7]

According to the WHO and UNICEF, a child needs to eat from at least five of the eight food categories in order to get the ideal amount of nutrition required for their overall growth.[8] The key to assessing nutritional adequacy in young children and newborns is to increase dietary diversity since it ensures enough intake of critical nutrients and a high-quality diet.[9] Therefore, a diet made up of a variety of food categories is crucial to ensuring enough nutrition, preventing malnutrition, and promoting healthy growth and development from infancy to adolescence.[10 11] Minimum dietary diversity (MDD) is an issue that both underdeveloped and wealthy countries are concerned about. Globally, less than one-third of infants and young children are receiving the recommended diversified diet, while South Asia and sub-Saharan African countries are in a dire situation here; only one out of every four children aged 6–23 months consumes a minimally diversified diet.[12] Data from the Demographic and Health Survey (DHS) (2017–2018) show that only 12% of under-5 children in Pakistan received the recommended minimum acceptable diet in 2018, where 21% met at least the MDD requirement and 38% met the minimum food frequency requirement.[13] In Nepal, only 36% of children met MDD[14]; and in India, it is 32.6%.[15] Bangladesh has a low level of dietary diversity, with only 41.9% of the population eating a variety of foods.[16] Achieving this minimum nutritional requirement is difficult, especially in low-income and middle-income countries where financial and food scarcities are common.

Furthermore, income inequality has demonstrated a persistent correlation with reduced achievement in MDD across the countries under consideration.[11 17 18] Among these nations, India exhibits the highest level of inequality, as evidenced by its Gini coefficient value of 35.7%. In contrast, the Maldives boasts the lowest inequality, with a Gini coefficient of 29.3%.[19] Notably, other countries included in this analysis, namely Bangladesh, India and Nepal, also grapple with substantial levels of income inequality within their respective borders. The significance of diverse food consumption in mitigating malnutrition is well acknowledged. However, comprehensive research is scarce in this realm. Notably, Harvey *et al* pointed out the absence of cross-national or subregional analyses on the variables impacting dietary diversity among young children.[18] Similarly, Belay *et al* emphasised the dearth of evidence concerning determinants of minimum dietary intake in South Asian nations.[20] Solomon *et al* highlighted a prevailing focus on community and rural contexts, leaving a gap in understanding how these factors influence minimum dietary intake across diverse countries within South Asia.[21]

In order to comprehensively enhance child health and nutritional well-being through comprehensive interventions, a nuanced understanding of the variations and underlying factors influencing MDD is essential. South Asian countries, such as Bangladesh, India, Nepal, Pakistan and Maldives, have similar socioeconomic contexts and cultural differences, but high rates of inadequate MDD in infants and young children. This makes it interesting and possible to compare the findings from these countries and develop similar policy recommendations. This study aims to determine the prevalence of socioeconomic inequalities in MDD and its potential determinants in these five countries. By addressing this research gap, the study hopes to provide valuable insights for designing targeted strategies and programmes to improve dietary diversity and the overall nutritional well-being of infants and young children in these countries.

METHODS

Data source and sampling

The study used the most recent round of secondary databases of Demographic Health Survey data of Bangladesh (2017–2018), India (2019–2021), Maldives (2016–2017), Nepal (2018) and Pakistan (2017–2018).[22–26] The survey was carried out in accordance with national regulations. The Demographic and Household Surveys are nationally representative household surveys that use a multistage, stratified sampling strategy to attain comprehensive information in terms of nutrition and health data on children, their parents and households. The first stage comprises the division of each country in geographical regions.[27] Urban or rural areas make up different strata of the people within these subnational regions. These main sample units, or clusters, are chosen with a probability proportionate to the population contribution of each cluster to the total population. All of the cluster's households are listed during the second sampling step, and an average of 25 of them are then randomly chosen for interviews using a systematic sampling method with equal probabilities.[28] The DHS report for the particular country has more details about the sampling process. The ever-married women who had children were questioned about their children's nutritional status.

Inclusion criteria

A total of five South Asian countries data were used for the study purpose and the factors of interest. The eligibility criteria for our analytical sample were as follows: children (a) born as singletons (b) who were alive and between the ages of 6 and 23 months at the time of the survey and (c) who had parents with appropriate dietary information, which refers to accurate and tailored guidance regarding nutrition and food choices that is specifically designed to support the growth, development and well-being of children. A total of 136 980 children, comprising 2447 (1.82%) from Bangladesh, 128 010 (93.93%) from India, 1716 (1.14%) from Maldives, 1479 (1.11%) from Nepal,and 3328 (2.00%) from Pakistan, were eventually confirmed for the analysis.

Outcome variable

The study's outcome variable, minimum dietary diversity (MDD), was determined through face-to-face interviews conducted with mothers.The variable was coded as 'yes'

if the child aged 6–23 months received food from at least five groups out of eight groups of food on the previous day of the survey; otherwise, the variable was coded as 'no'. The eight food groups are (1) breast milk, (2) grains, roots and tubers, (3) legumes and nuts, (4) dairy products (milk, yoghurt, cheese), (5) flesh foods (meat, fish, poultry and liver/organ meats), (6) eggs, (7) fruits and vegetables rich with vitamin A and (8) other fruits and vegetables.

Explanatory variables

Explanatory variables were grouped into the following categories: maternal and family factors, factors related to media exposure, factors related to health services use, and child factors. Maternal and family factors included the age group of mothers in years,[11 15–46] the mother's and partner's education level (no education, primary, secondary, higher), mother's employment (yes, no), partner's occupation (agriculture, services, others), household wealth status, which was used to calculate the concentration index (CIX) of dietary diversity, was determined to be one of the primary explanatory variables (poorest, poorer, middle, higher, highest) and place of residence (urban, rural). Watching television (TV) and reading newspapers/magazines (yes, no) were also taken into consideration when conducting the decomposition and regression model as factors related to media exposure. Factors related to health services use included the maternal postnatal visit (yes, no), number of antenatal care (ANC) visits (4 visits, ≥4 visits) and place of delivery (home delivery, facility delivery). Child factors included sex of the child (male, female), age of the children in months,[6–22] and the number of living children in the household (1, 2, ≥3 children).

Statistical analysis

The initial data refinement phase encompassed the inclusion of data specifically from children aged between 6 and 23 months. After this, during the second stage of data processing, any responses that were either incomplete or not reported for the variables required to compute dietary variety were omitted. This iterative process yielded a dataset comprising information from 136 980 children (unweighted).

To ensure the statistical robustness of our analyses on a national scale and when pooling data, we integrated sample weights, clustering and stratification characteristics sourced from DHS programme guidelines. Addressing the inherent interdependence among data points within clusters and households, we organised the data into clusters based on the primary sampling unit. In pooled analyses, we also considered latent country-level factors by adjusting observations based on population size and incorporating country-fixed effects. Our method involved creating two sets of binary logistic regression models for pooled analysis of the outcome. Initially, we employed separate single-adjusted models for each influencing factor. Subsequently, we constructed a mutually adjusted model, denoted as the fully adjusted model, where all significant factors were simultaneously considered.

The characteristics of the data and the distribution of dietary diversity among the explanatory variables are tabulated using simple descriptive statistics. Lorenz curve was constructed to determine whether there is an MDD inequality based on household wealth status. Plotting the cumulative proportion of respondents who reported having a minimum level of food diversity versus the cumulative proportion of respondents who reported having a minimum level of wealth status reveals the inequality in at least MDD. Any deviation from the line, which is marked by a 45° line, denotes the presence of inequality. Suppose the concentration curve is below the line of equality. In that case, it means that respondents with higher wealth status are more likely to have better than minimal dietary diversity. If the concentration curve is above the equality line, respondents with lower wealth status are more likely to have better than minimal dietary diversity.

The CIX was calculated to quantify the level of concentration. The formula developed by Kakwani,[29] Jenkins[30] and Kakwani *et al*[31] was used to calculate the CI, known as the convenient covariance approach. The formula is as follows:

$$CIX = \frac{2}{\mu} cov\left(h, r\right);$$

Here, μ is the weighted mean of the MDD, h is the MDD variable and r is the fractional rank of the individual in the distribution of household wealth status, cov(h, r) denotes the covariance between h and r. The user-written STATA commands Lorenz[32] and conindex[33] were used to produce the Lorenz curve and measure CIX, respectively. CIX takes values within the closed interval of −1 and+1. The closer the value of CIX to +1, the higher the concentration in the upper quantile of the variable by which concentration is calculated, and the closer the value of CIX to −1, the higher the concentration in the lower quantile of the variable by which concentration is calculated.

Patient and public involvement

Not applicable, as this study involves secondary data from DHS. Therefore, there is no direct patient involvement in this study.

RESULTS

Participants' characteristics

The study encompassed 136 980 South Asian women and their children aged 6–23 months. Notably, India constituted the largest proportion (n=1 28 824), followed by Pakistan (n=3328) and Bangladesh (n=2447). Within this collective dataset, approximately 51% of children were male, predominantly originating from rural settings (74.7%). The age distribution of children was mainly centred around 12–17 months (34.9%), followed by 18–23 months (31.7%).

Regarding maternal characteristics, 87% of participants opted for facility-based deliveries, yet a substantial portion lacked postnatal care (PNC) check-ups (62.9%) and a notable proportion underwent ANC check-ups (41.6%). Socioeconomic strata exhibited disparities, with 26% of children hailing from the poorest wealth quintiles, while merely 13.8% belonged to the most affluent families. Educationally, 31% of mothers had limited or no formal education, while a significant majority were not engaged in any occupation (79.6%). Maternal age distribution was skewed, with over half falling between 25 and 34 years, and a mere 6.9% were aged 35–49 years (table 1).

Prevalence of MDD

The overall weighted prevalence of at least MDD among children aged 6–23 months in South Asia was 23.37% (95% CI 23.15% to 23.60%). The country-specific prevalence of MDD among five South Asian countries has been illustrated in figure 1. The highest prevalence of MDD was found among children from Maldives (70.7%), followed by Nepal (44.5%) and Bangladesh (38%). In comparison, the lowest prevalence was found in Pakistan (14.2%), and the differences in the prevalence among those countries were statistically significant.

Factors associated with MDD

The factors associated with MDD found in the pooled analysis were: having ANC more than four times compared with those mothers who had ANC seeking less than four times and increasing age of the children. Other associated factors include: having a mother who is employed rather than an unemployed mother, living in an affluent household and reading newspapers and magazines more than four times per week (online supplemental table 1).

In India and the Maldives, maternal age (India: AOR: 1.27 (95% CI 1.12 to 1.43; p<0.001; Maldives: AOR: 2.04 (95% CI 1.29 to 3.22; p<0.002) was associated with an increased likelihood of MDD, but in all other countries, the association was inconsequential. In Bangladesh and Nepal, maternal higher and secondary level of education (Bangladesh: AOR: 2.41 (95% CI 1.23 to 4.72; p<0.010; Nepal: AOR: 3.88 (95% CI 1.35 to 11.16; p<0.012) was found to be connected with a greater likelihood of MDD. Children whose mothers were employed were more likely to increase the chances of MDD in both Bangladesh (AOR: 1.40 (95% CI 1.10 to 1.78; p<0.006) and India (AOR: 1.35 (95% CI 1.19 to 1.54; p<0.001). Only in Maldives is the father's secondary education deemed significant (AOR: 3.51 (95% CI 1.22 to 10.10; p<0.020). In India, fathers' involvement in agriculture (AOR: 1.21 (95% CI 1.05 to 1.40; p<0.008) was found to increase the chance of MDD, whereas in the Maldives it decreased the probability of greater than minimal dietary diversity. Bangladesh, India and Nepal were shown to have statistically significant associations with affluent households, whereas Maldives and Pakistan exhibited no association. The practice of reading newspapers and magazines was found to be significant in increasing the likeliness of MDD for both Bangladesh (AOR: 1.60 (95% CI 1.06 to 2.40; p<0.025) and India (AOR: 1.44 (95% CI 1.28 to 1.63; p<0.001). Seeking ANC has been demonstrated to raise the likeliness of having greater than minimal dietary diversity more than four times in Bangladesh (AOR: 1.55 (95% CI 1.21 to 1.98; p<0.001); India (AOR: 1.27 (95% CI 1.14 to 1.42; p<0.001), Maldives (AOR: 5.25 (95% CI 1.63 to 16.95; p<0.006). An increased likelihood of having more than minimal dietary diversity was associated with rising age across all five countries. However, in India, the number of children was the factor that increased the likelihood of having more than minimal dietary diversity (online supplemental table 2).

Measurement of inequalities in MDD

The Lorenz curves and CIX values were also used to evaluate household wealth-related inequalities in having MDD among children ages 6–23 months across five South Asian nations. Overall, the CIX value was positive (CIX: 0.035, p<0.0001; figure 2), suggesting that those from greater socioeconomic backgrounds had a higher MDD. Examining each country separately (Bangladesh CIX: 0.128, p<0.0001; India CIX: 0.027, p<0.0001; Maldives CIX: 0.029, p<0.2815; Nepal CIX: 0.101, p<0.0001 and Pakistan CIX: 0.226, p<0.0001), it was shown that the Lorenz curve for all five countries lays below the line of equality, indicating existing inequalities (figure 3). The gap between rich and poor is the widest in Bangladesh and Pakistan. We can use the Lorenz curves to quantify how far we are from full equality. The bigger the Gini coefficient, and therefore, the less equal the society, the further a Lorenz curve deviates from the perfectly equal straight line (indicating a Gini value of 0).

Decomposition analysis

The impact of major socioeconomic and demographic factors on MDD and inequalities are shown in table 2. The degree of change in the dependent variable, which is a socioeconomic imbalance of MDD, which resulted from a one-unit change in the exploratory variables is shown in the 'elasticity' column. Elasticity with a positive or negative sign indicates a positive change in the factor with a rising or falling trend in the facility's output. The values of CIX that were calculated in this analysis to determine the level of socioeconomic inequity have values between −1 and +1. However, if the MDDs are equally distributed among the socioeconomic groups, the CIX value becomes 0. In this study, the value of the CIX for MDD was found to be (MDD: CI=0.0351984, p<0.001) among children with a higher socioeconomic status, suggesting inequality in MDD in favour of the more affluent. The column 'CIX' displays the distribution of the determinants in terms of wealth quintiles. Whether the factors were more prominent in the affluent or poor group is shown by the positive or negative direction of the CIX. The

Table 1 Background characteristics of the study participants

Variables	Frequency	Percentage	Bangladesh	India	Maldives	Nepal	Pakistan
Maternal and family factors							
Age of the mother							
15–24	55 583	40.58	1321 (53.98)	52 156 (40.74)	360 (20.98)	788 (53.28)	958 (28.79)
25–34	71 818	52.43	972 (39.72)	67 318 (52.59)	1062 (61.89)	606 (40.97)	1860 (55.89)
35–49	9579	6.99	154 (6.29)	8536 (6.67)	294 (17.13)	85 (5.75)	510 (15.32)
Mothers' education							
No education	26 967	19.69	146 (5.97)	24 774 (19.35)	22 (1.28)	423 (28.60)	1602 (48.14)
Primary	16 653	12.16	666 (27.22)	15 030 (11.74)	258 (15.03)	287 (19.41)	412 (12.38)
Secondary	72 104	52.64	1180 (48.22)	68 468 (53.49)	1134 (66.08)	553 (37.39)	769 (23.11)
Higher	21 256	15.52	455 (18.59)	19 738 (15.42)	302 (17.60)	216 (14.60)	545 (16.38)
Mothers' occupation							
Had no work	22 635	79.69	1548 (63.26)	16 184 (83.27)	1174 (68.41)	749 (50.64)	2980 (89.57)
Had work	5770	20.31	899 (36.74)	3252 (16.73)	542 (31.59)	730 (49.36)	347 (10.43)
Fathers' education							
No education	4234	15.06	327 (13.55)	2822 (14.58)	40 (2.51)	180 (12.22)	865 (26.26)
Primary	4380	15.57	844 (34.96)	2350 (12.14)	396 (24.87)	325 (22.06)	465 (14.12)
Secondary	14 487	51.51	772 (31.98)	10 910 (56.38)	948 (59.55)	674 (45.76)	1183 (35.91)
Higher	5022	17.86	471 (19.51)	3268 (16.89)	208 (13.07)	294 (19.96)	781 (23.71)
Fathers' occupation							
Agriculture	4967	17.66	458 (18.73)	3588 (18.48)	250 (16.40)	266 (18.34)	405 (12.30)
Services	9864	35.06	559 (22.86)	7774 (40.03)	470 (30.84)	214 (14.76)	847 (25.71)
Other	13 302	47.28	1428 (58.40)	8058 (41.49)	804 (52.76)	970 (66.90)	2042 (61.99)
Household wealth status							
Poorest	35 733	26.09	522 (21.33)	33 700 (26.33)	440 (25.64)	360 (24.34)	711 (21.36)
Poorer	31 626	23.09	514 (21.01)	29 556 (23.09)	494 (28.79)	324 (21.91)	738 (22.18)
Middle	27 261	19.90	430 (17.57)	25 308 (19.77)	516 (30.07)	319 (21.57)	688 (20.67)
Richer	23 460	17.13	504 (20.60)	21 906 (17.11)	184 (10.72)	296 (20.01)	570 (17.13)
Richest	18 900	13.80	477 (19.49)	17 540 (13.70)	82 (4.78)	180 (12.17)	621 (18.66)
Place of residence							
Urban	29 121	21.26	811 (33.14)	25 824 (20.17)	150 (8.74)	834 (56.39)	1502 (45.13)
Rural	107 859	78.74	1636 (66.86)	102 186 (79.83)	1566 (91.26)	645 (43.61)	1826 (54.87)
Factors related to media exposure							
Watch TV							
No	45 166	32.97	924 (37.76)	42 064 (32.86)	124 (7.23)	579 (39.15)	1475 (44.32)
Yes	91 814	67.03	1523 (62.24)	85 946 (67.14)	1592 (92.77)	900 (60.85)	1853 (55.68)
Read newspapers/magazines							
No	99 017	72.29	2163 (88.39)	92 502 (72.26)	448 (26.11)	1145 (77.42)	2759 (83.00)
Yes	37 959	27.71	284 (11.61)	35 508 (27.74)	1268 (73.89)	334 (22.58)	565 (17.00)
Factors related to health services use							
Antenatal care visit (ANC)							
<4 (no ANC)	54 644	41.62	1270 (52.39)	51 356 (41.81)	40 (2.78)	412 (28.22)	1566 (49.97)
≥4 (had enough ANC)	76 648	58.38	1154 (47.61)	71 478 (58.19)	1400 (97.22)	1048 (71.78)	1568 (50.03)
Postnatal check-up							
No	37 986	62.94	560 (34.63)	35 372 (63.04)	1056 (85.44)	393 (73.73)	605 (70.10)

Continued

Table 1 Continued

Variables	Frequency	Percentage	Bangladesh	India	Maldives	Nepal	Pakistan
Yes	22369	37.06	1057 (65.37)	20734 (36.96)	180 (14.56)	140 (26.27)	258 (29.90)
Place of delivery							
Home	17599	12.85	1205 (49.24)	14808 (11.57)	74 (4.31)	507 (34.28)	1005 (30.20)
Facility delivery	119381	87.15	1242 (50.76)	113202 (88.43)	1642 (95.69)	972 (65.72)	2323 (69.80)
Child factors							
Sex of the children							
Male	70898	51.76	1264 (51.66)	66240 (51.75)	882 (51.40)	807 (54.56)	1705 (51.23)
Female	66082	48.24	1183 (48.34)	61770 (48.25)	834 (48.60)	672 (45.44)	1623 (48.77)
Child age in months							
6–8	22239	16.66	411 (16.80)	21218 (16.67)	262 (15.34)	117 (15.54)	231 (18.19)
9–11	22207	16.64	388 (15.86)	21236 (16.68)	278 (16.28)	124 (16.47)	181 (14.25)
12–17	46660	34.96	852 (34.82)	44486 (34.95)	562 (32.90)	241 (32.02)	519 (40.87)
18–23	42356	31.74	796 (32.53)	40344 (31.70)	606 (35.48)	271 (35.99)	339 (26.69)
Number of living children in the household							
1	50701	37.01	905 (36.98)	47862 (37.39)	606 (35.31)	619 (41.85)	709 (21.30)
2	46816	34.18	831 (33.96)	44172 (34.52)	602 (35.08)	424 (28.67)	787 (23.65)
≥3	39463	28.81	711 (29.06)	35976 (28.10)	508 (29.60)	436 (29.48)	1832 (55.05)

TV, television.

percentage contribution shows how much each model variable adds to overall socioeconomic differences in MDD. A component that is anticipated to widen socioeconomic gaps connected to MDD usage has a positive percentage contribution. On the other hand, a factor with a negative percentage contribution suggests a drop in disparities.

DISCUSSION

This study examines socioeconomic inequalities in MDD among children aged 6–23 months in South Asian countries and the associated factors. Children in Pakistan are the least likely to have access to minimal dietary variety (14.99%). In contrast, children in the Maldives have the highest MDD access (69.46%). Similar results have been

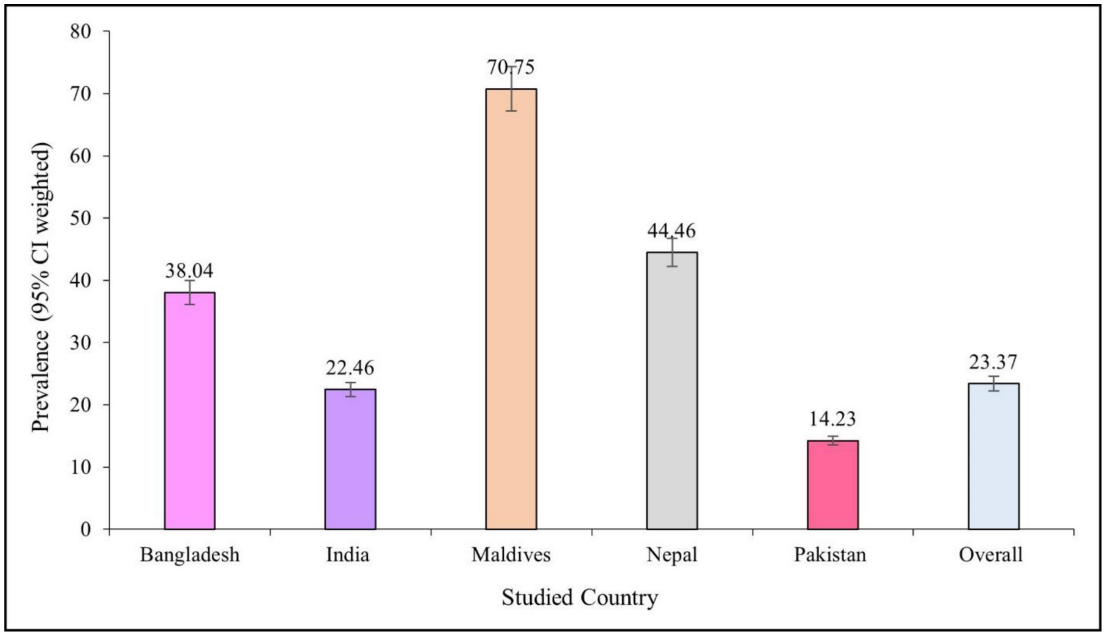

Figure 1 Weighted prevalence of minimum dietary diversity among children (6–23 months).

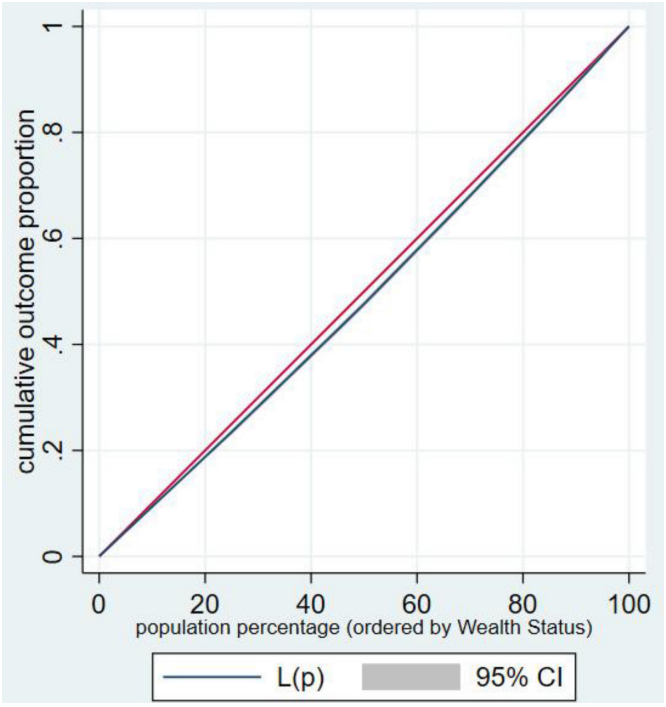

Figure 2 Lorenz curve of minimum dietary diversity against the wealth status (pooled data).

observed in other developing countries, with low MDD rates.[34 35] The lower achievement of MDD in Pakistan can be primarily attributed to widespread poverty, limited access to education, healthcare, sanitation and political instability.[36] Conversely, the Maldives' higher MDD attainment can be linked to relative economic stability, efficient resource distribution due to a smaller population and geographical layout, and a cultural emphasis on diverse dietary practices.[37 38]

This study highlights pronounced disparities in income levels in Bangladesh and Pakistan compared with other nations, potentially playing a role in the lower achievement of MDD in these countries.[38] Conversely, Maldives exhibits the lowest wealth inequalities and the highest attainment of dietary diversity. This observation underscores a clear correlation between income inequality and the ability to achieve MDD. The nexus between income and dietary diversity is further elucidated by the fact that individuals with limited financial resources, prevalent among lower-income populations, often face challenges in accessing a variety of nutrient-rich foods.[11] The higher cost of fresh produce and lean proteins creates a financial barrier, compelling individuals with lower incomes to opt for more affordable yet less nutritious alternatives. This economic divide contributes to disparities in dietary choices and nutritional outcomes, highlighting the importance of addressing income inequality to improve overall nutritional well-being.[17]

The increased inequality in these regions can be attributed to constrained access to quality education and human capital development, challenges in land ownership and agrarian structures. Varying degrees of industrialisation and urbanisation, coupled with potential labour exploitation, also play a role.[39] These underlying factors may exert an indirect impact on MDD, as evidenced in our study by the observed lower attainment rate.[34 35]

Children with older mothers were more likely to have MDD than children with younger-aged mothers, and this finding is in line with the previous study

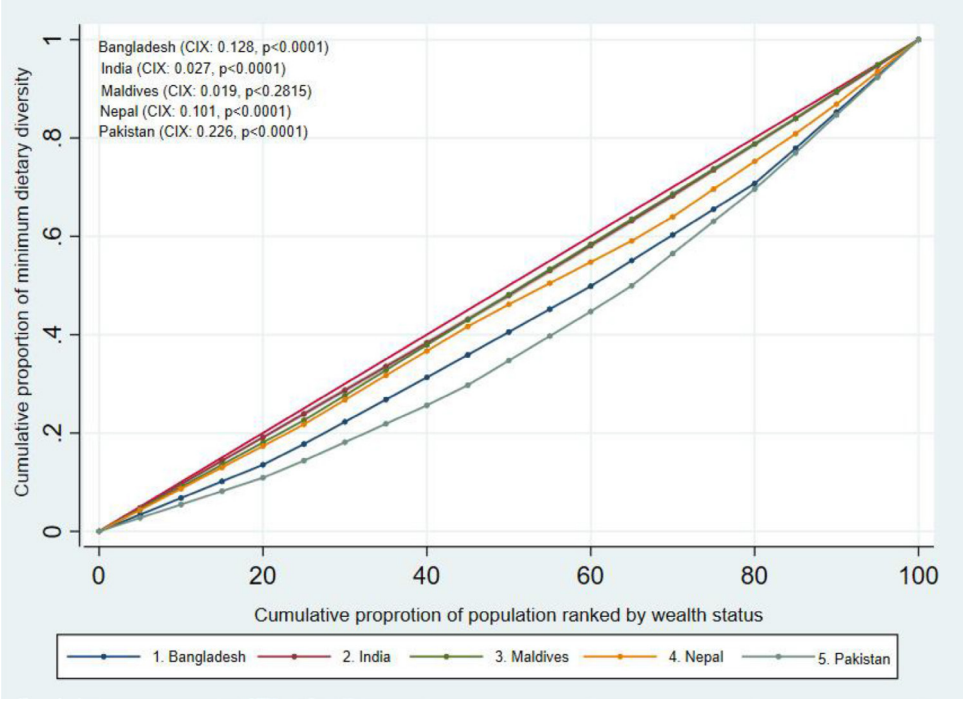

Figure 3 Lorenz curve of minimum dietary diversity by country against the wealth status (pooled data).

Table 2 Decomposition of the concentration index (CI) obtained with respect to wealth index

			Contribution to overall CI=0.0352 P<0.001	
	Elasticity	CI	Contribution	Percentage of contribution
Age of the mother				
15–24 (RF)				
25–34	0.0208	0.0608	0.0013	3.5825
35–49	0.0056	−0.0221	−0.0001	−0.3516
Subtotal			**0.0012**	**3.2309**
Maternal education				
No education (RF)				
Primary	−0.0030	−0.2490	0.0008	2.1362
Secondary	0.0311	0.0398	0.0012	3.5158
Higher	0.0162	0.4907	0.0079	22.5460
Subtotal			**0.0099**	**28.198**
Maternal occupation				
Had no work (RF)				
Had work	0.0377	−0.0914	−0.0034	−9.7884
Parental education				
No education (RF)				
Primary	0.0098	−0.2399	−0.0023	−6.6534
Secondary	0.0115	0.0450	0.0005	1.4746
Higher	−0.0050	0.4214	−0.0021	−6.0403
Subtotal			**−0.0039**	**−11.2191**
Parental occupation				
Other (RF)				
Agriculture	0.0192	0.0509	0.0010	2.7689
Services	−0.0186	0.0541	−0.0010	−2.8605
Subtotal			**0.0000**	**−0.0916**
Household wealth status				
Poorest (RF)				
Poorer	0.0088	−0.3141	−0.0028	−7.8522
Middle	0.0416	0.0996	0.0041	11.7803
Richer	0.0173	0.4874	0.0084	23.9379
Richest	0.0413	0.8372	0.0346	98.2128
Subtotal			**0.0443**	**126.0788**
Watch TV				
No (RF)				
Yes	0.0067	0.1844	0.0012	3.5256
Read newspapers/magazines				
No (RF)				
Yes	0.0562	0.3225	0.0181	51.4637
Antenatal care contacts (ANC)				
<4 (RF)				
≥4	0.1665	0.1064	0.0177	50.3377
Postnatal check-up				

Continued

Table 2 Continued

			Contribution to overall CI=0.0352 P<0.001	
No (RF)				
Yes	–0.0394	0.0699	0.0028	7.8225
Place of delivery				
Home delivery (RF)				
Facility delivery	–0.0273	0.0433	–0.0012	–3.3576
Sex of the children				
Male	–0.0193	0.0041	–0.0001	–0.2249
Female				
Child age in months				
0 to <6 months (RF)				
6–8 months	1.5180	0.0002	0.0003	0.9814
9–11 months	1.6931	0.0025	0.0042	11.8979
12–17 months	3.5120	0.0127	0.0446	126.7494
18–23 months	3.3063	–0.0150	–0.0496	–140.7875
Subtotal			**–0.0005**	**–1.1588**
Number of living children				
≥3 (RF)				
1	0.0496	0.1026	0.0051	14.4550
2	0.0702	0.0529	0.0037	10.5609
Subtotal			**0.0088**	**25.0159**
Place of residence				
Urban	–0.0049	0.4324	–0.0021	–6.0036
Rural (RF)				
Studied country				
Pakistan (RF)				
Bangladesh	0.0111	0.0527	0.0006	1.6559
India	0.0393	–0.0033	–0.0001	–0.3641
Maldives	0.0181	0.0626	0.0011	3.2207
Nepal	0.0086	0.0187	0.0002	0.4576
Subtotal			0.0018	4.9701
Explained CIX=0.0946				
Residual CIX=–0.0594				

Subtotal values (for more than one categories) are presented with bold letters
RF, Reference category; TV, television.

conducted in Bangladesh.[40] This could be due to older mother having adequate experience in taking care of their children and being more conscious about their children's feeding practices which makes a difference and increase the MDD among their children.[41 42] We found that children from households with media access, such as watching TV or reading newspapers/magazines were more likely to have MDD than those from the family with no media access. Existing information from different sources indicated similar findings that having media access increases the level of MDD in children.[43–45] Another Bangladeshi study[46] also found a positive association between maternal media exposure and adequate complementary feeding of children. Though media exposure is commonly associated with higher levels of education and wealth, it has a discernible impact on MDD. The underlying rationale could be that media-derived information influences parents to enhance the dietary diversity of their children.[43 47] This could

have occurred due to national radio and TV advertisements promoting children's health.[48]

Children whose mothers were concerned about maternal healthcare services and used ANC, PNC and institutional delivery were more likely to have higher MDD compared with the children whose mothers had not used these facilities. Previous studies also identified that more maternal ANC visits and PNC check-ups are associated with higher MDD in children.[16 49 50] Using health facilities during delivery was also an associated factor in an earlier study in Tanzania.[51] Healthcare providers provide information about maternal health and child health, consulting and discussing the importance of dietary diversity for children during ANC visits, PNC visits or during institutional delivery, which might help increase parents' understanding towards child MDD.[43 52]

Results demonstrate that parental education is significantly associated with MDD among South Asian countries' children and showed a positive trend as the parents' education leads to an increase in MDD of their children compared with the children with no educated parents. Several studies in countries such as Myanmar, Indonesia and South-East Asia illustrate the relationship between parental education and MDD and point out a positive association.[16 53 54] Parental education is the primary element that possibly improves the guidance to enhance the knowledge about maternal health, child health and child nutrition, increasing the MDD among the children.[18 53] Moreover, education gives opportunity to parents to engage in paid job which is conducive to buy enough foods for the family and children.[21 55] Our study showed a positive association between working mothers and a higher rate of MDD, which is in line with the previous literature[51] This might be because mothers who are involved in an income-earning job are able to purchase a different kind of food, ensuring an MDD for their children. Furthermore, earning mothers tend to be autonomous in decision-making for their household, which leads to an improved quality diet for their family and their children.[56 57]

Similarly, children from the wealthiest quintile had a higher likelihood of receiving MDD compared with children from the poorest quintile. This difference could be attributed to household members in the poorest quintile consuming food with less diversity and struggling to maintain MDD due to financial constraints.[43 58] In the face of a financial crisis, children from the poorest quintile face barriers to nutritious food as their parents may struggle to provide diverse diets compared with parents in the most affluent quintile. Furthermore, the findings from this study suggest that access to MDD decreases as inequality within the country, with Pakistan scoring the lowest in the attainment of MDD among children aged 6–23 months. This aligns with similar findings in several studies, confirming that the richest wealth quintile has higher access to MDD.[35 43 58 59] This relationship between wealth quintiles and MDD access may be attributed to the domino effect of inequality within a country, affecting various sectors, including education, health services and government services. Moreover, governmental efforts towards international and national nutrition programmes and addressing cultural barriers may also play a role in MDD.[60]

However, due to limitations in available secondary data, we excluded variables such as ethnicity, health expenditure and household food security in our analysis, variables such as ethnicity, health expenditure, household food security linked to MDD was not possible to include due to missing variables and missing information in the original DHS dataset. In addition, due to the cross-sectional nature the causative direction of the identified components, and the use of 24-hour recall data for MDD are some of its significant limitations. The strengths of this study are the inclusion of variables such as media exposure, health services use in the multivariable analysis, which increases the validity of the findings. Furthermore, we have used five nationally representative latest cross-sectional DHS datasets from five South Asian countries, which is our greatest strength.

Past studies[61] found these variables significant for predicting MDD.[61–63] Ethnicity may have varied national and country-specific effects on MDD.[63] Similarly, health and food expenditure within households[62] could be influential. Although our analysis could not quantify their contributions, future research should include these variables for a more comprehensive understanding of MDD determinants.

POLICY IMPLICATIONS

Despite impressive success in eliminating maternal and child mortality and malnutrition in this region, many children still do not have a good variety of foods in their diets. This study revealed a glaring imbalance between countries with low dietary diversification. In response, stakeholders must establish tailored initiatives, programmes and policies. Leveraging mass media for health education and advocating for mandatory female education can effectively promote dietary diversity, as indicated by this study's findings. Furthermore, the implementation of a targeted cash transfer programme, specifically designed to provide direct financial assistance to families living in poverty, particularly those within the lowest income quintiles, can play a pivotal role in addressing the issue. Urgent attention is needed to implement cross-sectoral measures that enhance dietary variety services across all nations in the region.

CONCLUSION

In conclusion, among South Asian infants aged 6–23 months, there were substantial inequalities favouring the rich in terms of having better than minimal dietary diversity. We found that maternal age, education and

occupation, the status of watching TV and reading newspapers, ANC and PNC check-ups of mothers, age of the children, place of delivery, and the number of living children in the household in the households were significantly associated with MDD in children. The findings suggest that these can be possible targets of future interventions to improve MDD among children in South Asia, particularly among those who belong to economically poor households. The findings of this study also suggest that while developing health policy, it is important to consider both the level of socioeconomic disparity in MDD and its associated factors. Researching successful strategies from other countries can provide valuable insights for refining action plans in similar contexts, offering potential solutions to improve dietary diversity and nutritional outcomes. Moreover, implementing longitudinal studies incorporating diverse indicators such as ethnicity, health expenditure and maternal body mass index, child birth weight along with a decomposition approach to the CIX regarding explanatory variables, would aid in identifying contributing factors to inequalities in MDD. This approach enables a more precise prediction of specific factors behind these inequalities and their impact on MDD attainment. Our research adds to the body of data from subnational levels in five South Asian nations demonstrating the urgent need for coordinated action on subnational level awareness and successful strategic initiatives in South Asian nations to curb the socioeconomic inequalities in MDD among children.

Contributors MAR contributed to literature search, data analysis and interpretation, figures and tables, and writing the manuscript draft and contributed to the revision. Moreover, he is the guarantor for this study and will take full responsibility for the work and also have access to the data. SK contributed to the design of the manuscript, development of the protocol and data analysis plan and provided oversight and interpretation of the analyses, writing of the manuscript draft, and a critical review of the manuscript. HOR contributed to the writing of the manuscript and draft tables preparation. MAI contributed to the review of the study design, data interpretation, and writing of the manuscript draft. MMT contributed to designing and writing the manuscript draft and contributed to the revision. MAR and SK had access to the data in the study and took responsibility for the data's integrity and data analysis's accuracy. All authors gave final approval of the version to be published. MAR attested that all listed authors meet authorship criteria.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study does not involve human participants or animal subject and ethical approval was not required. This study involves secondary data from Demographic and Health Survey (DHS).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. This study used the publicly available Demographic and Health Surveys (DHS) Programme dataset of Bangladesh, which can be obtained freely from https://dhsprogram.com/. As a third-party user, we do not have permission to share the data publicly on any platform. Data are accessible free of charge upon registration with the Demographic and Health Survey programme (The DHS Programme).

ORCID iDs
Satyajit Kundu http://orcid.org/0000-0001-9610-1479
Harun Or Rashid http://orcid.org/0000-0003-2396-2168
Mortuja Mahamud Tohan http://orcid.org/0000-0003-1202-8732

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