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Malnutrition et morbidité chez les enfants en Afrique: Concentration et inégalités socioéconomiques familiales et communautaires

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Executive summary

Malnutrition and infectious diseases among preschoolers feature prominently among the major public health concerns in developing countries. Existing evidence tends to support the view that despite the dramatic improvement in human health in the past decades, the gap between rich and poor remains very wide, just as it does also between the better-off and disadvantaged groups defined, for example, by education, job status, housing standards, and place of residence. Addressing the problems of inequalities in child health, both between countries and within countries, remains therefore one of the greatest research challenges and is of special appeal for policies and programs targeting child's welfare and survival.

The methodological goal of this dissertation is to develop and test measures of socioeconomic status (SES) for predicting health status in developing countries. Its substantive goal is to examine variations among communities in childhood malnutrition and morbidity, and to investigate how the SES of communities and that of households affect child health regardless of their individual characteristics, and how they interact in this process. We use data from the Demographic and Health Surveys (DHS) of five African countries (Burkina Faso, Cameroon, Egypt, Kenya, and Zimbabwe).

We have constructed three relevant and complementary socioeconomic indexes which are household wealth index, household social index, and community SES. The bivariate relationships between these SES measures and selected health outcomes are consistent with expectations, and show important features of the social and socioeconomic inequalities in health status between and within countries in Africa. Multivariate analyses results show that variations in childhood malnutrition and morbidity among communities are clearly accounted for by contextual factors over and above likely compositional effects. This finding which is in line with most studies upholds a key role for community context as a strong influence on health, and supports the growing body of research suggesting that neighborhood characteristics

per se exert an important influence on the resident's health. Unlike most other studies, our results show that urban-rural differentials in childhood malnutrition are almost entirely accounted for by the SES of communities and families. Socioeconomic inequalities are however higher in urban centres than in rural areas.

This study also shows that there is a strong patterning in child nutritional status along SES lines, with household wealth status emerging as the most powerful predictor since its effects outweigh in virtually all countries and time periods the influences of the two other socioeconomic indexes, and community SES having in some instances an independent contribution above the effects of the SES of households. Moreover, living in poorest socioeconomic conditions increases the odds of suffering from both malnutrition and diarrhea, as opposed to experiencing only one of the two outcomes. On the other hand, with the exception of Cameroon and to a lesser degree Kenya, socioeconomic inequalities have generally tended to narrow, with however statistically significant changes in very few cases.

Finally, this dissertation shows that community SES significantly modifies the association between household SES and child health, according to patterns mainly consistent with *initiating/enlarging* model (as community SES initiates or enlarges the effects of the household SES on child health). Patterns of *lessening/eliminating* model (when the effects of household SES decrease with increasing community SES) also emerge from our results. This finding suggests that corollary measures to improve access of mothers and children to basic community resources such as health services and clean water may be necessary preconditions for higher levels of household socioeconomic situation to contribute to improved child health.

Key words:

Socioeconomic Status, Inequalities, Clustering, Malnutrition, Diarrhea morbidity, Multilevel models, Cross-level interaction, Conditional effects, Africa

Résumé

La malnutrition et les maladies infectieuses chez les enfants d'âge préscolaire constituent l'un des problèmes majeurs de santé publique dans les pays en développement. En dépit de l'amélioration constante de l'état de santé de la population africaine au cours des dernières décennies, il semblerait que l'écart entre groupes socioéconomiques définis par exemple en termes d'éducation, d'emploi ou de lieu de résidence, persiste voire se creuse. L'examen des questions d'inégalités face à ces pathologies, entre pays et au sein des pays constitue donc un défi et un enjeu notamment pour les politiques et programmes destinés à l'amélioration du bien-être et de la survie des enfants.

Cette thèse s'est fixée comme objectif méthodologique la construction de mesures du statut socioéconomique (SSE) pour l'étude des questions de santé dans les pays en développement. Son objectif substantif est d'examiner la concentration et les inégalités socioéconomiques communautaires et familiales des problèmes nutritionnels et de morbidité chez les enfants d'âge préscolaire en Afrique. Des données issues des Enquêtes Démographiques et de Santé (EDS) de cinq pays africains (Burkina Faso, Cameroun, Egypte, Kenya et Zimbabwe) sont utilisées.

Nous avons construit trois mesures du SSE à savoir le statut économique du ménage, le statut social du ménage, et le SSE de la communauté. Les relations bivariées entre ces mesures du SSE et différentes variables de santé montrent une amélioration de l'utilisation des services de santé et une baisse des taux de malnutrition et de mortalité, avec l'augmentation du SSE familial ou communautaire. Les analyses multivariées montrent qu'il y a une concentration communautaire de la malnutrition et de la diarrhée chez les enfants qui persiste même après contrôle pour les caractéristiques familiales et individuelles, ce qui suggère la présence d'effets contextuels et renforce le rôle de la communauté comme source potentielle d'influence sur la santé de ses résidents. Nos résultats révèlent en outre, contrairement à d'autres études, que les différences entre les milieux urbains et

ruraux dans la prévalence de malnutrition et la morbidité s'expliquent presque entièrement par le SSE des ménages et des communautés. Les inégalités socioéconomiques sont cependant plus élevées en milieux urbains qu'en zones rurales.

Cette thèse montre aussi que les mesures du SSE sont fortement associées à la malnutrition et la morbidité infantiles. Des trois mesures, le statut économique du ménage ressort comme le facteur ayant le plus fort pouvoir explicatif dans l'ensemble, et le SSE communautaire exerce dans certains cas une influence indépendante. De plus, les enfants vivant dans des conditions défavorisées sont plus à risque de souffrir à la fois de la malnutrition et de la diarrhée, que de souffrir de l'une seulement de ces deux pathologies. Par ailleurs, à l'exception du Cameroun et dans une certaine mesure du Kenya, les inégalités socioéconomiques ont eu tendance à diminuer dans le temps, bien que peu de changements soient significatifs.

Enfin, notre étude révèle que le SSE communautaire modifie très nettement les effets des variables du SSE familial, le plus souvent selon un modèle d'accentuation, en ce sens que les effets du SSE du ménage sur la malnutrition et le morbidité augmentent avec le niveau de développement socioéconomique de la communauté. Dans certains cas, cette interaction se manifeste selon un schéma d'atténuation, les effets du SSE du ménage diminuant avec l'augmentation du SSE communautaire. Ce résultat suggère que l'amélioration de l'accès des mères et de leurs enfants à des ressources communautaires de base comme les services de santé et l'eau potable, pourrait être l'une des conditions préalables pour que l'amélioration du SSE des ménages contribue au bien-être des enfants.

Mots clés :

Statut socioéconomique, Inégalités, Concentration, Malnutrition, Diarrhée, Modèles multi-niveaux, Interaction, Effets conditionnels, Afrique.

Table des matières

Identification du jury
Résumé i
Executive summary iii
Table des matières v
Liste des Tableaux viii
Liste des Figures x
Liste des Sigles et abbréviations xi
Dédicace xii
Remerciements xiii

Introduction

1. Problématique et objectifs de l'étude 1
2. Concentration et inégalités socioéconomiques devant la santé 3
   2.1. Concentration communautaire des problèmes de santé 3
   2.2. Inégalités socioéconomiques devant la santé 5
   2.2.1. Mesure du statut socioéconomique 5
   2.2.2. Influences socioéconomiques sur la santé 7
3. Données et méthodes 8
   3.1. Données utilisées 8
   3.2. Méthodes statistiques 11
4. Plan de la thèse 12
Annexe : Carte de l'Afrique 13b

Chapitre 1: Measuring socioeconomic status in health research in developing countries: Should we be focusing on households, communities or both?

Abstract 14
1. Introduction 15
2. Rationale for household and community socioeconomic indexes 16
   2.1. Socioeconomic index or socioeconomic indicators? 17
   2.2. Should we focus on households, communities or both? 18
3. Data and methods 22
   3.1. Data and selected countries 22
   3.2. Methods 25
4. Assessing the constructed indices 28
   4.1. Proportion of variance accounted for by the first principal component 28
   4.2. Internal coherence and robustness of the indices 30

5. Socioeconomic indices, health-seeking behaviour, health and nutritional status 33
5.1. Household wealth index and health outcomes 40
5.2. Household social status and health outcomes 41
5.3. Community endowment index and health outcomes 42
6. Conclusion 43
References 46
Appendix 1. Statistical procedures for constructing the indexes utilised in analyses 51

Chapitre 2: Household and community socioeconomic influences on early childhood malnutrition in Africa

Abstract 54
1. Introduction 55
2. Conceptual framework 57
3. Materials and methods 60
3.1. Dependent variables 63
3.2. Key independent variables 64
3.3. Control variables 65
3.4. Statistical methods 65
4. Findings 68
4.1. Descriptive analyses 68
4.2. Variability in child stunting among communities 73
4.3. Urban-rural differentials in childhood malnutrition 74
4.4. Gross estimates of socioeconomic influences on child malnutrition 78
4.5. Net effects of household and socioeconomic influences on child malnutrition 79
5. Discussion 81
Appendix 1. Definitions and specifications of variables used in analyses 85
References 86

Chapitre 3: Socioeconomic inequalities in early childhood malnutrition and morbidity: Modification of the household-level effects by the community socioeconomic status

Abstract 90
1. Background 91
2. Conceptual framework 94
2.1. Socioeconomic factors 94
2.2. Effects modification: Cross-level socioeconomic interactions 97
2.3. Co-occurrence of malnutrition and diarrhea morbidity 97

3. Data and methods 98
3.1. Data 98
3.1.1. Dependent variables: Nutritional and morbid statues 98
3.1.2. Defining community 100
3.1.3. Independent variables: Socioeconomic status 100
3.1.4. Measuring inequalities in child health 102
3.2. Statistical methods 103
4. Results 106
4.1. Descriptive analyses: Socioeconomic inequalities in child health 106
4.2. Clustering among communities in child health 108
4.3. Socioeconomic influences on child health 111
4.4. Co-occurrence of malnutrition and diarrhea morbidity 117
4.5. Modification of the household socioeconomic effects by the community SES 119
5. Summary and discussion 122
References 125

Conclusion

1. Principaux résultats 129
2. Discussion des résultats et implications 131
3. Quelques pistes pour les recherches futures 134
Références bibliographiques 136

Liste des tableaux

Introduction

Tableau 1. Malnutrition chronique chez les enfants préscolaires dans les pays en développement 9

Tableau 2. Indicateurs socioéconomiques des cinq pays sélectionnés 10

Chapitre 1:

Table I. Sample characteristics of Demographic and Health Surveys (DHS) in selected African countries 23

Table II. Definitions and specifications of variables used in the analyses 26

Table III. Factor analysis outputs: Proportion of variance explained by the first principal component 29

Table IV. Internal coherence of Household wealth index: Average asset ownership across wealth quintile groups 31

Table V. Household Wealth status and Health outcomes in Africa 34

Table VI. Household Social status and Health outcomes in Africa 35

Table VII. Community Endowment status and Health outcomes in Africa 36

Table VIII. Relative change in the health outcomes levels and poorest/richest gaps between the two periods. 44

Chapitre 2:

Table 1. Hierarchical distribution of the number of units at each potential level of analysis 70

Table 2. Prevalence of stunting by place of residence, and poor/rich ratio according to household and community SES 70

Table 3. Estimates (coefficients) of the variation among communities and families, and the urban-rural differentials in childhood malnutrition 75

Table 4. Estimates (coefficients) of the gross socioeconomic effects on childhood malnutrition 76

Table 5. Estimates (coefficients) of the net socioeconomic effects on childhood malnutrition 77

Appendix 1. Definitions and specifications of variables used in analyses 85

Chapitre 3:

Table 1. Multilevel estimates (coefficients) of the contextual and socioeconomic effects on childhood stunting 112

Table 2. Multilevel estimates (coefficients) of the contextual and socioeconomic effects on childhood underweight 113

Table 3. Multilevel estimates (coefficients) of the contextual and socioeconomic effects on childhood diarrhea morbidity 114

Table 4. Socioeconomic influences (coefficients) on the co-occurrence stunting-diarrhea among children 115

Table 5. Socioeconomic influences (coefficients) on the co-occurrence underweight-diarrhea among children 116

Table 6. Conditional effects (coefficients) of the household wealth status on childhood malnutrition and morbidity 120

Table 7. Conditional effects (coefficients) of the household social status on childhood malnutrition and morbidity 121

Liste des figures

Chapitre 1:

Fig. 1. Household Wealth status and Health outcomes in Africa 37

Fig. 2. Household Social status and Health outcomes in Africa 38

Fig. 3. Community Endowment status and Health outcomes in Africa 39

Chapitre 2:

Figures 1 to 3. Household wealth status, Household social status, Community socioeconomic status, and early childhood malnutrition 71

Figures 4 to 6. Household wealth, Household social, and Community socioeconomic inequalities in child malnutrition by place of residence: Concentration index 72

Chapitre 3:

Figure 1. Conceptual framework for the analysis of household and community socioeconomic influences on child health 96

Figures 2 to 4. Community SES, household wealth status, household social status, and malnutrition and morbidity among children in the DHS-1 109

Figures 5 to 8. Prevalence (%) and socioeconomic inequalities in malnutrition and morbidity among children 110

Liste des sigles et abréviations

ARI	Acute Respiratory Infections
CDC	US Center for Disease Control
DHS	Demographic and Health Survey
EDS	Enquête Démographique et de Santé
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
IRA	Infections Respiratoires aiguës
LCI	Living Conditions Index
MPE	Malnutrition Protéino-Energétique
MQL	Marginal Quasi Likelihood
NCHS	US National Center for Health Statistics
OMS	Organisation Mondiale de la Santé
PCA	Principal Components Analysis
PEM	Protein-Energy Malnutrition
PIB	Produit Intérieur Brut
SCP	Social and Cultural Planning Office
SES	Socioeconomic Status
SIDA	Syndrome Immuno-Déficitaire Acquis
SSE	Statut Socioéconomique
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
VIH	Virus de l'Immunodéficience Humaine
WHO	World Health Organization

Dédicace

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Introduction

1. Problématique et objectifs de l'étude

Les carences nutritionnelles chez les enfants d'âge préscolaire, sous leurs différentes formes dont les plus étudiées sont la malnutrition[1] protéino-énergétique (MPE) et les carences en vitamine A, en fer et en iode, constituent l'un des problèmes majeurs de santé publique dans les pays en développement. Leurs conséquences à court et à long terme comprennent l'augmentation des risques de morbidité et de mortalité, le retard dans le développement intellectuel, et un déficit de productivité à l'âge adulte (De Onis et al., 2000; UNICEF, 1998; Adair & Guilkey, 1997 ; Kuate-Defo, 2001). Dans le même temps, les maladies infectieuses au premier rang desquelles la diarrhée, la rougeole, les infections respiratoires aiguës (IRA), le paludisme, et plus récemment le virus de l'immunodéficience humaine/syndrome immuno-déficitaire acquis (VIH/SIDA) contribuent à la malnutrition et causent l'essentiel des décès chez les enfants dans les pays en développement (WHO, 1999 ; Emch, 1999). En conséquence, les enfants vivant dans des conditions défavorisées sont souvent enfermés dans un cercle vicieux malnutrition, affaiblissement du système immunitaire et vulnérabilité aux maladies infectieuses, conduisant davantage à une détérioration du statut nutritionnel (Brown, 2003; Tomkins and Watson, 1989; Scrimshaw et al., 1968).

Les causes de la malnutrition et de la morbidité sont multiples, multisectorielles et imbriquées, et exercent leurs influences aux niveaux individuel, familial, communautaire et national. La pauvreté joue à cet égard un rôle central à la fois comme cause directe des problèmes de santé, et comme déterminant d'autres facteurs plus proches tels le faible accès aux aliments pouvant fournir une ration alimentaire adéquate, l'accès limité aux services de santé et à l'éducation, les conditions défavorables d'hygiène, de salubrité et d'habitat, ainsi

[1] Bien que les problèmes d'obésité soient de plus en plus rencontrés dans les pays en développement, le terme malnutrition dans cette étude fait référence à la malnutrition par carence.

que la taille élevée des familles (Gopalan, 2000; Emch, 1999; FAO, 1997). Ce qui fait du statut socioéconomique (SSE) des individus, des ménages et des communautés un déterminant fondamental de la malnutrition et de la morbidité.

Par ailleurs, comme l'illustre le Tableau 1 (page 9), le statut nutritionnel des enfants s'améliore dans certaines parties de l'Afrique et dans les autres régions du monde en développement, mais semble se détériorer dans d'autres régions du continent, notamment en Afrique de l'Est. Ces disparités dans les niveaux et les tendances des problèmes nutritionnels s'observent également entre pays au sein des régions, et pourraient également exister entre communautés et autres groupes de population au sein des pays. D'où l'intérêt de s'interroger sur la concentration et sur les facteurs socioéconomiques explicatifs des problèmes nutritionnels et de morbidité au sein des communautés et des familles en Afrique, avec une attention sur les enfants d'âge préscolaire étant donné que dans la plupart des sociétés africaines, ils sont les plus vulnérables de la population.

L'examen des questions d'inégalités socioéconomiques devant la santé et particulièrement celle des enfants, entre pays et au sein des pays ayant des niveaux de développement social, économique et culturel variés, constitue en effet un défi et un enjeu major, notamment pour les politiques et programmes destinés à l'amélioration du bien-être de et de survie des enfants (Feachem, 2000 ; Alvarez-Dardet, 2000). L'importance de ces questions d'inégalités devant la santé est clairement soulignée par l'Organisation Mondiale de la Santé (OMS) qui indique:

> "*... But [a good health system] is not always satisfactory to protect or improve the average health of the population, if at the same time inequality worsens or remains high because the gain accrues disproportionately to those already enjoying better health. The health system also has the responsibility to try to reduce inequalities by preferentially improving the health of the worse-off, wherever these inequalities are caused by conditions amenable to intervention. The objective of good health is really twofold: the best attainable average level (goodness), and the smallest feasible differences among individuals and groups (fairness)*" (WHO, 2000).

C'est dans cette optique que s'inscrit la présente étude consacrée à l'examen de la concentration et des inégalités socioéconomiques face aux problèmes nutritionnels et de morbidité chez les enfants d'âge préscolaire en Afrique, avec un accent sur l'évaluation des changements dans le temps. Plus précisément les objectifs poursuivis sont :

1. De construire des mesures de SSE pour la recherche en santé, dans un cadre conceptuel tenant compte du caractère multi-niveaux des déterminants de la santé, puis de tester la force de leur association avec différents problèmes de santé dont l'utilisation des services de santé, la malnutrition et la mortalité;
2. D'évaluer la concentration de la malnutrition et de la morbidité infantiles au sein des communautés, et d'examiner dans quelle mesure elle est expliquée par des effets contextuels au delà des effets de composition ;
3. D'étudier les influences du SSE des ménages et des communautés sur la santé des enfants, et leur évolution dans le temps, avec une attention particulière sur l'examen (i) de l'importance relative des différentes mesures du SSE ; (ii) des effets du SSE sur le différentiel urbain-rural ; (iii) du différentiel urbain-rural dans les niveaux d'inégalités ; et (iv) de la co-occurrence malnutrition-morbidité ;
4. D'examiner dans quelle mesure le SSE communautaire a une contribution indépendante à la malnutrition et la morbidité, et dans quelle mesure il atténue ou accentue les effets du SSE familial.

2. Concentration et inégalités socioéconomiques devant la santé

2.1. Concentration communautaire des problèmes de santé

Il est généralement admis que les problèmes de santé sont plus semblables chez des personnes issues du même ménage ou résidant dans la même communauté, que chez celles vivant dans des familles et/ou communautés différentes, en raison notamment du fait que les premières

partagent un ensemble de caractéristiques communes ou sont exposées à un ensemble de conditions (Diez-Roux, 1998; Duncan et al., 1996; Macintyre et al., 1993 ; Madise et al., 1999). La question de la concentration des problèmes de santé au sein des familles ou des communautés revêt une importance majeure, car elle peut fournir des indications sur le niveau d'influence des facteurs de risque du phénomène de santé étudié, et permettre de mieux orienter les programmes d'interventions vers les ménages et/ou les communautés (Katz et al., 1993a). Cette préoccupation a donné lieu à un grand nombre d'études. Les épidémiologistes se sont depuis longtemps intéressés à l'examen de la concentration spatiale, temporelle ou spatio-temporelle des maladies (Mantel, 1967; Knox, 1964), principalement par le biais de tests statistiques basés sur des comparaisons entre le nombre de cas observés et le nombre théorique résultant d'une distribution aléatoire. En dépit de leur pertinence pour détecter les poches de concentration dans l'espace et/ou dans le temps, ces méthodes parce qu'essentiellement descriptives ne permettent pas d'identifier les causes ou du moins les déterminants du phénomène étudié.

Si dans le domaine des sciences sociales, les chercheurs ont récemment entrepris l'étude des déterminants de la concentration de la mortalité au sein des familles ou communautés (Kuate & Diallo, 2002; Sastry, 1997; Das Gupta, 1997), le sujet a été très peu abordé pour les questions de malnutrition et de morbidité. Les approches utilisées dans les rares études sur la malnutrition et la morbidité incluent notamment les rapports de côtes croisés (pairwise odds ratios en anglais) ou les modèles de type beta binomial (Katz et al., 1993a; 1993b).

Dans un contexte où l'on reconnaît la nature multi-niveaux des facteurs de risque, la concentration est mieux capturée à travers la variabilité inter- et intra-communautaire du phénomène sous étude (Madise, 1999), comme nous le faisons dans la partie de cette recherche qui se rapporte à notre deuxième objectif. De plus, cette approche permet

d'examiner dans quelle mesure ces variations sont expliquées par des variables de niveau familial ou individuel (Diez-Roux, 2001 ; Duncan et al., 1998).

2.2. Inégalités socioéconomiques devant la santé

L'aspect de notre recherche qui suit logiquement l'examen de la question de concentration se rapporte à l'étude des inégalités socioéconomiques au niveau familiale ou communautaire. Plusieurs travaux ont en effet montré des relations significatives entre SSE et problèmes de santé dans différents pays en développement et à différentes périodes (Kuate-Defo, 1996; Adair and Guilkey, 1997; Ricci and Becker, 1996; Emch, 1999 ; Etiler et al., 2004 ; Armar-Klemesu et al., 2000 ; Bicego & Boerma, 1993 ; Dargent-Molina et al., 1994 ; Forste, 1998 ; Madise et al., 1999 ; Sandiford et al., 1995 ; Tharakan & Suchindran, 1999). Ces études ont montré en particulier que les personnes de conditions socioéconomiques défavorables sont plus à risque de connaître des problèmes de santé que les personnes privilégiées notamment par l'éducation, l'emploi, les revenus et les conditions d'habitat (Kuate-Defo, 1996). Bien que ces travaux aient contribué à éclairer notre connaissance des influences socioéconomiques sur la santé dans les pays en développement, notre étude vise à tester et proposer d'autres approches non explorées, notamment dans le contexte africain.

2.2.1. Mesure du statut socioéconomique

Une approche que cette thèse explore dans le cadre de l'examen du premier objectif indiqué ci-dessus concerne la définition et la mesure du SSE. En effet, malgré l'intérêt et les progrès de la recherche sur les déterminants socioéconomiques de la santé, il n'y a pour l'heure de consensus ni sur la définition ni sur la mesure du concept de SSE (Lynch and Kaplan, 2000; Campbell and Parker, 1983; Cortinovis et al., 1993; Oakes and Rossi, 2003). Dans ce contexte, les travaux portant sur les pays du Sud utilisent en général différents indicateurs de niveau individuel, familial ou communautaire dont l'éducation de la mère, les possessions du

ménage, la propriété foncière, la source d'approvisionnement en eau, le type des toilettes, l'habitat, et le milieu de résidence. Outre le fait que chaque auteur utilise ses propres indicateurs, ce qui rend difficile les comparaisons, cette approche pose des problèmes d'ordre méthodologique. En effet, lorsque des variables sont fortement corrélées comme le seraient certains indicateurs de SSE, il est peut être difficile d'estimer leurs effets dans un même modèle statistique (Campbell & Parker, 1983 ; Cortinovis et al., 1993 ; Durkin et al., 1994). De plus, ces approches tiennent généralement très peu compte de l'éducation du père, malgré le fait que dans certains contextes des pays en développement, des comportements et pratiques qui influencent la santé des enfants dépendent du père, ou plus précisément de son niveau d'éducation (Kuate-Defo and Diallo, 2002).

A la suite des travaux réalisés par Gwatkin et al. (2000) et Filmer & Pritchett (2001), nous construisons à partir d'analyses en composantes principales, trois mesures du SSE à savoir (i) le statut économique du ménage défini à partir des possessions, de l'approvisionnement en eau, du type de toilettes et des caractéristiques de l'habitat ; (ii) le statut social du ménage défini à partir de l'éducation et l'occupation de la mère et du père ; et (iii) le statut socioéconomique de la communauté, construit à partir de la proportion de ménage ayant accès à l'eau potable, à l'électricité, au téléphone, ainsi que de différentes variables de disponibilité de services socioéconomiques dans la communauté lorsque ces données existent[2]. En plus de distinguer les facteurs socioéconomiques par niveau d'influence (ménage, communauté), cette construction rend possible l'examen de la question de savoir si les effets socioéconomiques sur la santé sont principalement le fait de facteurs liés à la pauvreté et aux conditions matérielles, ou de facteurs tels l'éducation et l'emploi qui généralement précèdent le revenu et les possessions des ménages (Rahkonen et al., 2002; Lynch and Kaplan, 2000 ; Kawachi et al., 2002).

[2] Le volet communautaire a été réalisé seulement dans les EDS du Burkina Faso (1992/93), du Cameroun (1991), du Kenya (1993) et du Zimbabwe (1994).

Il est important de souligner qu'en l'absence d'une bonne mesure du SSE, les effets des autres facteurs couramment mis en évidence - tels que l'utilisation des services de santé, la taille et la structure familiale, les intervalles entre naissances, le statut nutritionnel de la mère, le faible poids à la naissance des enfants - ne peuvent pas être convenablement estimés, car ces facteurs sont eux-mêmes susceptibles d'être influencés par le SSE (voir cadre conceptuel, page 88 chapitre 3). Une bonne mesure du SSE pourrait également permettre de mieux estimer l'effet du milieu de résidence (urbain-rural) dont Sastry (1997) estime qu'il est probablement le plus important après celui de l'éducation de la mère, pour les études sur la santé dans les pays en développement.

2.2.2. Influences socioéconomiques sur la santé

Les démarches adoptées par la plupart des auteurs n'ont pas souvent tenu compte de manière explicite de la structure hiérarchique des données dans la modélisation des effets, bien que l'hétérogénéité ait été pris en compte, mais sans distinction par niveau (communauté, ménage, mère, enfant, par exemple). Il est en effet couramment admis qu'à moins d'une prise en compte de la corrélation potentielle entre observations de même niveau, les modèles statistiques tendraient à sous-estimer les écart-type, ce qui aurait une conséquence sur le degré de significativité des effets (Duncan et al., 1998; Rasbash et al., 2002 ; Raudenbush & Bryk, 2002; Goldstein, 1999). Notre étude utilise une démarche qui considère simultanément les différents niveaux auxquels s'exercent les effets.

Pour l'étude des influences socioéconomiques, cette thèse examine également les interactions du SSE avec le milieu de résidence en vue de comparer l'étendue des inégalités en milieu urbain versus milieu rural. Elle approfondit en outre l'analyse et l'interprétation de l'interaction entre SSE communautaire et SSE familial, en vue d'examiner entre autres dans

quelle mesure le premier atténue ou accentue les effets du second, et donc de savoir si l'amélioration du SSE du ménage a plus (ou moins) d'effets dans les communautés démunies que dans les communautés développées (Dargent-Molina et al., 1994; Robert, 1999 ; Gordon et al., 2003).

Par ailleurs, un certain nombre de travaux ont mis en évidence l'effet du statut nutritionnel sur l'occurrence de la diarrhée (Etiler et al., 2004; Emch, 1999), ou l'effet de la diarrhée sur l'état nutritionnel (Tharakan and Suchindran, 1999; Madise et al., 1999). Avec des données transversales (comme c'est le cas pour ces études), les deux variables sont potentiellement endogènes, l'un influençant l'autre comme indiqué plus haut. Une manière de contourner ce problème consisterait, comme nous le faisons dans cette thèse, à les traiter toutes deux comme variables dépendantes, en examinant par exemple la présence de la malnutrition seule, de la morbidité seule, ou des deux simultanément.

3. Données et méthodes

3.1. Données utilisées

Cette étude utilise les données nationales comparatives issues du programme des Enquêtes Démographiques et de Santé (EDS) de cinq pays africains ayant réalisé plus d'une enquête au cours de la décennie 1990 : Burkina Faso (1992/93, 1998/99); Cameroun (1991, 1998); Egypte (1992, 2000); Kenya (1993, 1998) et Zimbabwe (1994, 1999). Les enquêtes EDS fournissent des informations détaillées sur la santé et l'état nutritionnel des mères âgées de 15-49 ans et de leurs enfants nés au cours des trois ou cinq dernières années précédant l'enquête, ainsi que sur les caractéristiques des enfants, des mères, des ménages et des communautés. En raison de l'utilisation de questionnaires standard, et de plan d'échantillonnage et de collecte similaires d'un pays à l'autre, les EDS offrent une source unique de données représentatives au plan national qui se prêtent aisément à la comparaison

entre pays et entre périodes au sein d'un même pays, et ce pour une vaste gamme d'indicateurs de santé (Boerma & Sommerfelt, 1993).

Tableau 1. Malnutrition chronique chez les enfants préscolaires dans les pays en développement.

	Prévalence (en %)				Nombre (en millions)			
	1990	1995	2000	Var[a]	1990	1995	2000	Var
All developing countries	39.8	36.0	32.5	-7.3	219.7	196.6	181.9	-37.8
Africa	37.8	36.5	35.2	-2.6	41.7	44.5	47.3	5.6
Eastern Africa	47.3	47.7	48.1	0.8	17.1	19.3	22.0	4.9
Northern Africa	26.5	23.3	20.2	-6.3	5.6	4.9	4.4	-1.1
Western Africa	35.5	35.2	34.9	-0.6	12.0	13.5	14.7	2.8
Middle and Southern Africa[b]	36.3	30.9	25.0	-11.3	7.0	6.9	6.1	-0.9
Asia	43.3	38.8	34.4	-8.9	167.7	143.5	127.8	-39.9
Latin America and the Caribbean	19.1	15.8	12.6	-6.5	10.4	8.6	6.8	-3.6

Source : De Onis et al. (2000)
[a]Ecart absolu entre 2000 et 1990; [b]Non fourni par De Onis et al. (2000), calculé par différence.

Dans cette étude, la malnutrition est définie par la malnutrition chronique (stunting) et l'insuffisance pondérale (underweight)[3], mesurées par les indices taille-pour-l'âge et poids-pour-l'âge respectivement. Comme recommandé par l'Organisation Mondiale de la Santé (OMS), les enfants dont l'indice se situe à plus de deux écart-type en dessous de la médiane de la population de référence NCHS/CDC/WHO[4] sont classés comme mal nourris. Par ailleurs, l'état de morbidité se rapporte aux déclarations de la mère sur les épisodes de diarrhée[5] au cours des deux dernières semaines précédant la date de l'enquête.

Les cinq pays retenus affichent des niveaux de développement variés, le Burkina Faso étant l'un des pays les plus pauvres (classé 45è en Afrique selon l'indice de développement humain, juste devant le Mozambique, le Burundi, le Niger et la Sierra Leone), et l'Egypte l'un

[3] La malnutrition aiguë (wasting), n'est pas utilisée du fait de son caractère volatile au cours des saisons et périodes de maladie (World Bank, 2002), et de son faible niveau relatif de prévalence.
[4] US Center for Health Statistics/US Center for Disease Control/World Health Organization.
[5] Les infections respiratoires aiguës (l'autre variable de morbidité fournie par les EDS) ne sont pas retenues du fait du nombre élevé de valeurs manquantes (près de 70% au Burkina Faso (1992/93), Cameroun (1991) et Egypte (1992)).

des pays les plus développés (7è rang), comme l'atteste le Tableau 2. Selon des estimations les plus récentes pour l'année 2000, le produit intérieur brut (PIB) par habitant à prix constants varie de près de 250 $US au Burkina Faso à 1 230 $US en Egypte, pour une moyenne continentale proche 737,5 $US. L'espérance de vie à la naissance se situe à 67 ans en Egypte et varie de 40 ans au Zimbabwe à 51 ans au Cameroun ; le taux d'analphabétisme qui est de l'ordre de 40% en moyenne sur le continent atteint 77% au Burkina Faso, 45% en Egypte, et varie entre 25%, 20% et 12% respectivement au Cameroun, Kenya et Zimbabwe (World Bank, 2002 ; UNDP, 2002).

Tableau 2. Indicateurs socioéconomiques des cinq pays sélectionnés

Pays[a] ==========>>>>>	BFS	CAM	EGP	KEN	ZBW	Africa
1. Population (millions)	11.3	15.1	63.8	30.1	12.6	797.8
2. % Population urbaine	18.5	48.9	45.2	33.1	35.3	37.9
3. PIB[b], per capita à prix contants	251.5	665.2	1 229.2	328.1	622.1	737.5
4. Espérance de vie à la naissance	45	51	67	48	40	51
5. Taux d'anaphabétisme	77.0	25.0	45.0	19.0	12.0	40.0
6. Taux bruts de scolarisation primaire	40.0	85.0	101.0	85.0	112.0	80.0
7. Rang selon l'IDH[c]	45	18	7	17	14	na

Source: African Development Indicators 2002, The World Bank
[a]BFS (Burkina Faso); CAM (Cameroun); EGP (Egypte); KEN (Kenya); ZBW (Zimbabwe).
[a]Produit intérieur brut (en $US, 1995); [c]Indice de développement humain des pays africains

Bien que ces pays ne soient pas représentatifs du continent, leur localisation dans les cinq grandes régions de l'Afrique à savoir l'Ouest (Burkina Faso), le Centre (Cameroun), le Nord (Egypte), l'Est (Kenya) et le Sud (Zimbabwe), pourrait autoriser quelques généralisations. Ce d'autant que ces régions offrent elles-mêmes une grande diversité dans leurs niveaux de développement social, économique et culturel, et dans les niveaux et tendances des problèmes nutritionnels. La prévalence de la malnutrition chronique se situe dans toute l'Afrique autour de 35% entre 1990 et 2000, mais atteint environ 48% dans l'Est (près d'un enfant sur deux), contre 20% en Afrique du Nord (Tableau 1). S'agissant des tendances, le taux global de malnutrition s'est réduit de 2,5 points pourcentage (-7% en termes relatifs) entre les deux

périodes, mais le nombre d'enfants en situation de malnutrition s'est au contraire accru de 5,6 millions (+13,5%). En Afrique de l'Est, le taux est en hausse de près d'un point pourcentage, ce qui fait augmenter le nombre d'enfants de près de 4,9 millions (+29%), tandis que l'Afrique du Nord et l'Afrique centrale et australe connaissent une baisse de la prévalence et du nombre absolu d'enfants souffrant de malnutrition. Entre ces deux extrêmes, l'Afrique de l'Ouest enregistre un niveau et une tendance de prévalence proches de la moyenne continentale (De Onis et al., 2000).

3.2. Méthodes statistiques

Nous allons utiliser dans la présente étude des méthodes statistiques descriptives et explicatives. A l'aide d'analyses en composantes principales, nous procéderons à la construction des variables de SSE, exprimées comme combinaisons linéaires d'indicateurs socioéconomiques. La première composante principale (que nous retenons comme mesure du SSE) est mathématiquement déterminée de manière à maximiser sa variance ou (ce qui revient au même) la somme des carrés de ses corrélations partielles avec les indicateurs utilisés pour sa construction. Dans le cadre des analyses descriptives, ces indices de SSE (qui sont des variables continues) sont transformés en variables catégorielles par exemple avec des modalités notées : plus pauvres[6] (20% de queue) ; faibles (20% suivant) ; milieu (20%), élevés (20% suivant), et plus riches (20% de tête). Une série d'analyses bivariées permet de décrire l'association entre le SSE et différentes variables de santé. Enfin, nous évaluons les niveaux d'inégalités socioéconomiques au moyen d'indices de concentration (voir chapitre 3).

Des modèles multi-niveaux sont ensuite utilisés pour estimer la concentration au sein des communautés et des familles, et pour quantifier les influences socioéconomiques de la malnutrition et de la morbidité infantiles, et ce contrôlant pour différentes variables

[6] Les termes "pauvres" et "riches" sont utilisés à titre illustratif, et ne se rapportent pas à une définition de la pauvreté ou de la richesse.

pertinentes de niveau enfant, ménage ou communauté. En effet, la structure hiérarchique des données EDS, où les enfants sont nichés chez les mères, ces dernières nichées dans les ménages et les ménages nichés dans les communautés, introduit une possibilité de corrélation entre les observations de même niveau, ce qui viole l'hypothèse d'indépendance à la base de la plupart des modèles d'analyse à un seul niveau. En plus de tenir compte de cette corrélation, les méthodes multi-niveaux permettent également d'estimer la variabilité du phénomène étudié par niveau, de séparer les effets contextuels des effets de composition, et d'examiner à travers les interactions, dans quelle mesure une variable d'un niveau donné modifie les effets de variables à d'autres niveaux.

Les données EDS ont une structure à quatre niveaux à savoir enfant, mère, ménage et communauté. Cependant, avec une moyenne dans nos données de moins de deux enfants (âgés de cinq ans et moins) par mère, et de moins de deux mères (d'enfants de cinq ans et moins) par ménage, nous avons défini des modèles à deux niveaux, enfant et communauté. Des modèles de régression logistique à deux niveaux sont ainsi utilisés pour les variables dépendantes binaires (malnutrition, diarrhée), et les modèles de régression polytomique pour les variables dépendantes ayant plus de deux modalités (malnutrition-diarrhée).

4. Plan de la thèse

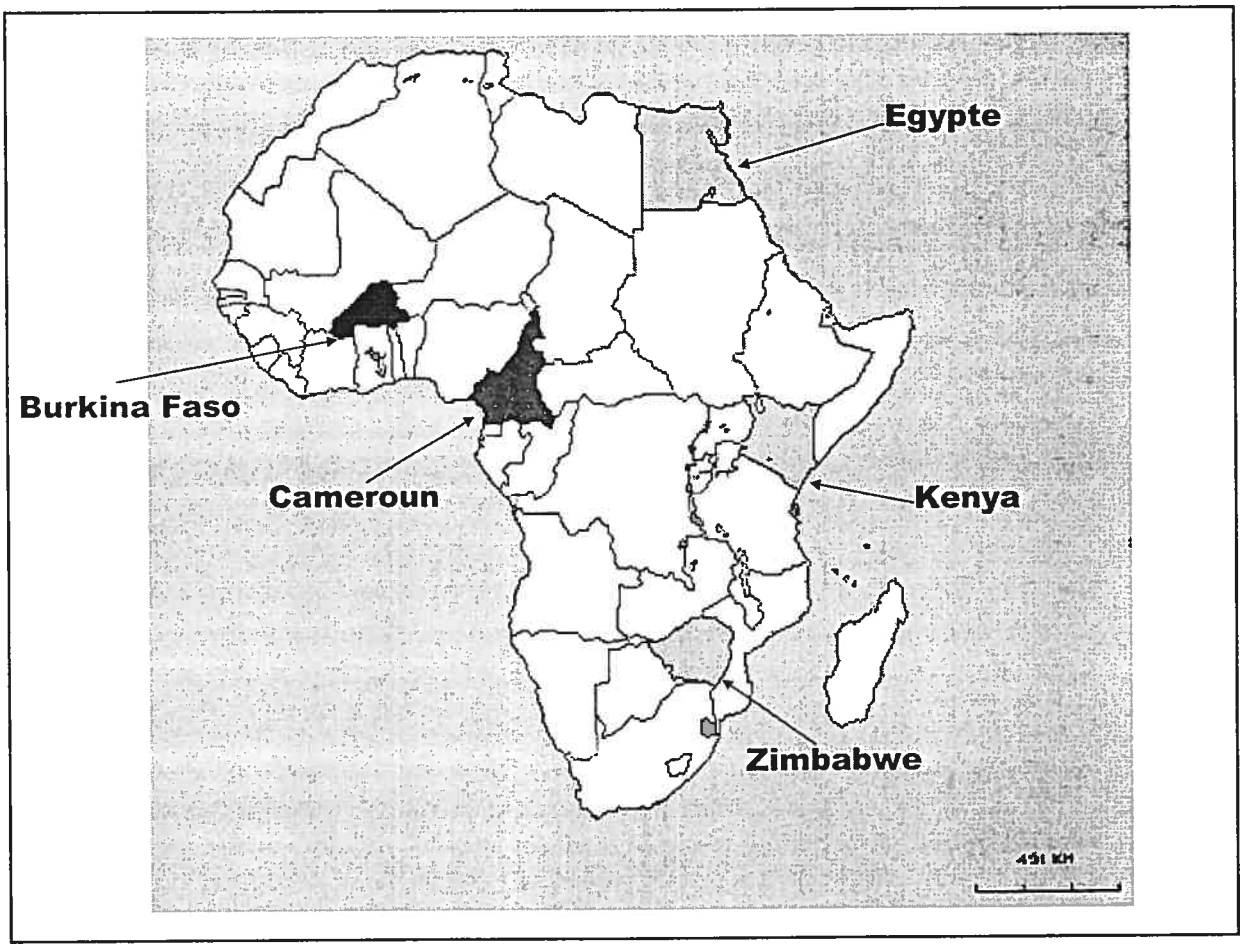
Cette thèse rédigée par articles comprend outre la présente partie introductive, trois chapitres correspondant à trois articles - tous acceptés pour publication - et une conclusion. Le chapitre 1 traite de la mesure du SSE pour les études des questions de santé dans les pays en développement, et ce dans un cadre de référence multi-niveaux (communauté, ménage). Le pouvoir explicatif de ces mesures du SSE est ensuite testé sur différentes variables à savoir l'utilisation des services de santé, la malnutrition et la mortalité.

Le chapitre 2 porte sur la malnutrition chronique. Il est consacré à l'évaluation de la concentration au sein des communautés; à l'exploration des différentiels urbain-rural et leur explication par les mesures du SSE familial et/ou communautaire ; et à l'étude des influences des mesures du SSE, avec une attention particulière sur l'examen de leur interaction avec le milieu de résidence, et de l'effet indépendant du SSE communautaire.

Dans le chapitre 3, nous élargissons les questions abordées au chapitre précédent à l'insuffisance pondérale, la diarrhée, la co-existence diarrhée-malnutrition chronique et diarrhée-insuffisance pondérale. Nous examinons en particulier dans quelle mesure le SSE communautaire atténue ou accentue les effets du SSE de niveau ménage.

Enfin, la conclusion fournit une présentation et discussion des principaux résultats et de leurs implications. Elle indique également quelques pistes pour des recherches futures.

Carte de l'Afrique



Chapitre 1

Measuring socioeconomic status in health research in developing countries: Should we be focusing on households, communities or both?

Measuring Socioeconomic Status in Health Research in Developing Countries: Should we be Focusing on Households, Communities or both?

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Abstract

Research on the effects of socioeconomic well-being on health is important for policy makers in developing countries, where limited resources make it crucial to use existing health care resources to the best advantage. This paper develops and tests a set of measures of socioeconomic status indicators for predicting health status in developing countries. We construct socioeconomic indexes that capture both household and community attributes so as to allow us to separate the social from the purely economic dimensions of the socioeconomic status within a cross-national perspective, with applications to data from Demographic and Health Surveys (DHS) fielded in five African countries in the 1990s. This study demonstrates the distinctive contributions of socioeconomic indexes measured at the household versus community level in understanding inequalities in health and survival and underlines the importance of going beyond the purely economic view of socioeconomic status to cover the multi-dimensional as well as multilevel concept of economic and social inequality.

Key words: Socioeconomic status, Inequality, Health, Malnutrition, Mortality, Africa

1. Introduction

The relationships between socioeconomic status (SES) of individuals and their health are well documented in the international epidemiological, economic and sociological literature and from a variety of perspectives (Cortinovis et al., 1993; Durkin et al., 1994; Kawachi et al., 2002; Krieger et al., 1997; Lynch and Kaplan, 2000; Morris and Castairs, 1991; Oakes and Rossi, 2003; Robert, 1999). There is consistent evidence that the socioeconomically better-off individuals do better on most measures of health status including mortality, morbidity, malnutrition and health care utilisation. This inverse association has been detected between health outcomes and a matrix of SES indicators based on data collected at the individual, household and community levels, including the traditional education, occupation and income measures, information on household possessions and level of community development. This type of research on the effects of socioeconomic well-being on health is important for policy makers in developing countries, where limited resources make it crucial to use existing health care resources to the best advantage (Kuate-Defo, 1997).

Although SES is not in itself a causal factor, understanding its linkages to health can provide clues to the actual mechanisms involved (Oakes and Rossi, 2003). In the social and biomedical sciences for instance, researchers are increasingly well aware of the fact that focusing on individuals outside of their historical, social and biophysical contexts may hamper our understanding of disease etiology, health and intervention strategies. Paradoxically, despite the overwhelming interest and progress in SES in health-related research, its conceptualization or measurement remain unsettled (Kaplan and Lynch, 1997; Krieger et al., 1997; Lynch and Kaplan, 2000; Alder et al., 1993; Campbell and Parker, 1983). Moreover, there is still no consensus on its nominal definition or a widely accepted measurement tool (Campbell and Parker, 1983; Morris and Carstairs, 1991; Cortinovis et al., 1993; Durkin et al., 1994; Oakes and Rossi, 2003).

Since different SES indicators may be correlated with one another, their use in the same statistical model is usually called into question with arguments invoking problems of multicollinearity, instability of estimated parameters and their interpretation (Campbell and Parker, 1983; Alder et al., 1993; Boniface and Tefft, 1997; Montgomery et al., 2000). Against this cautionary background, several researchers have predicted health outcomes focusing on a single variable as a proxy for socioeconomic indicator such as individual (maternal) education (Armar-Klemesu et al., 2000; Bicego and Boerma, 1991; Cebu Study Team, 1991; Das Gupta, 1990; Desai and Alva, 1998; Hobcraft, 1993; Kuate-Defo, 2001; 1997; 1996; Lamontagne et al, 1998; Reed et al., 1996; Ricci and Becker; 1996; Sommerfelt, 1991; Victoria et al., 1992), household income, possessions and dwelling characteristics including sanitation and water availability (Bateman and Smith, 1991; Szwarcwald et al., 2002; Gaminirante, 1991; Kuate-Defo, 2001; Sommerfelt, 1991).

The aim of this paper is to develop and test a set of measures of socioeconomic status indicators for predicting health status in developing countries. We construct SE indexes that capture both household and community attributes so as to allow us to separate the social from the purely economic dimensions of the SES within a cross-national perspective, with applications to data from the Demographic and Health Surveys (DHS) fielded in five African countries in the 1990s.

2. Rationale for household and community socioeconomic indexes

In this section we present two key issues that have an important bearing on assessing the association between SES and health: (i) the need to construct SES index rather than using SES indicators individually; (ii) the need to measure the specific contribution of household-level and community-level attributes and the relevance of separating the social from the purely economic effects of household SES variables.

2.1. Socioeconomic index or socioeconomic indicators?

Methodologically, using different socioeconomic indicators together in a single equation is somewhat questionable for substantive and statistical reasons. The substantive issue regards the interpretation of estimates with correlated or redundant predictors. The second is concerned with the multicollinearity threat and the subsequent danger of over-interpreting unstable coefficients (Campbell and Parker, 1983). On the other hand, many studies analyse SES inequality using income as indicator. This indicator does not however always match with particular goods related to welfare even if they are measured in monetary terms (Quadrado et al., 2001).

A number of socioeconomic indexes have been devised for use in health research in developed countries, including Duncan's index that classifies occupation according to education and income (Oakes and Rossi, 2003), Townsend's index designed mainly to explain area variation in health indicators in terms of material deprivation or for planning health care delivery (Morris and Castairs, 1991), the living conditions index (LCI) developed by the Social and Cultural Planning Office (SCP) of the Netherlands to assess the dispersion and concentrations of well-being in areas amenable to action by government policy such as housing, health, leisure activity, and ownership of consumer durables (Boelhouwer and Stoop, 1999). In the developing world, there have been few attempts to create socioeconomic index for use in social or health research, based on housing quality indicators such as wall and roofing material, cooking and lighting fuel, source of drinking water, sewage system, tenure (Fiadzo et al., 2001), on household wealth, housing, education and occupation (Durkin et al., 1994), or on a broader sequence of familial living conditions namely housing, literacy and cultural aspects, demographic conditions, economic conditions (Cortinovis et al., 1993). It is worth mentioning also the Human Development Index developed by the United Nations Development Program (UNDP), which captures the average of the measurement in three dimensions: longevity indicator based on life expectancy at birth, educational attainment based on

the percentage of the literacy of the adult population and the children's school enrolment, and resource indicator based on the per capita Gross Domestic Product (GDP). It is well known that these three dimensional indicators are highly correlated (Lai, 2000). Hence, although relevant in improving our understanding of the linkages between socioeconomic status and health, these socioeconomic indexes are unlikely to be used for comparisons across a range of developing countries since they are rarely developed within such comparative perspective.

2.2. Should we focus on households, communities or both?

The second issue concerns the distinctive contribution of household versus community attributes, and we argue that such distinction fosters our understanding of the link between socioeconomic status and health. Whilst the focus on individuals is often the logical starting point, it is necessary to consider the characteristics of the immediate (family/household) environment as well as the community development where individuals live besides usual individual- and household-level socioeconomic predictors, as there is growing evidence documenting the role of context in health inequalities. Hence, differences in the SES of communities may reflect more than different distribution of individuals nested within families and households and having distinct characteristics in these communities (Mosley and Chen, 1984; UNICEF, 1990; Cebu Study Team, 1991; Robert, 1999; Diez-Roux, 2002; 2001; 2000; 1998; Duncan et al., 1998; 1996; Kawachi et al., 2002; Lynch and Kaplan, 2000; Macintyre et al., 2002; 1993; Macintyre and Ellaway, 2000). These frameworks suggest that a range of socioeconomic factors operate through more proximate determinants of health to influence health status. Among these factors at the parental/household-level are variables such as education and employment; household's income and ownership of consumer durables, water, sanitation and housing; at the community-level are covariates capturing the availability of health-related services and relevant socioeconomic infrastructures.

Fathers' education usually correlates strongly with occupation and income, and therefore is a strong determinant of the household's assets and the marketable commodities the household consumes. Thus, in many instances correlations between health and fathers' education largely occur because of operations on the proximate determinants through the income effect. Regarding mothers, their skills operate directly on the proximate determinants. Her educational level and occupation can affect child's health by influencing her choices, increasing her skills and improving behaviors related to preventive care, nutrition, hygiene, breastfeeding, parity and birth intervals (Mosley and Chen, 1984). Typically, inadequate or improper education, particularly of women often exacerbates their inability to generate resources for improved nutrition for their families (UNICEF, 1990). Indeed, a number of studies have supported the evidence that mother's schooling is a stronger determinant of child welfare, yet they have shown some inconsistencies about the magnitude and significance of its effects compared to those of other SE indicators such as income or wealth (Armar-Klemesu et al., 2000; Bicego and Boerma, 1991; Desai and Alva, 1998; Ruel et al., 1992). In this regard, good care practices can mitigate the negative effects of poverty and low maternal schooling on children's nutritional status (Ruel et al., 1999; Lamontagne et al., 1998; Reed et al., 1996).

The household socioeconomic factors mainly influence its member's health through the income and wealth effects. In the absence of reliable information on income, there are many indicators that may capture the household's financial ability to secure goods and services that promote better health, help to maintain a more hygienic environment, and ensure adequate nutrition needs. For example, lack of ready access to water and poor environmental sanitation are important underlying causes of both malnutrition and diseases. These conditions directly affect health, food preparation and general hygiene. Inadequate access to water also affects nutrition indirectly by increasing the work-load on mothers, thus reducing the time available for child care. The presence of electricity, radio, television, the availability of transportation means as well as housing – both size and quality - also

feature prominently among the household-level determinants of child's health (Mosley and Chen, 1984; UNICEF, 1990; Kuate-Defo, 2001; Bateman and Smith, 1991).

Community socioeconomic factors may influence health through two major pathways: by shaping the household-level SES; and by directly affecting the social, economic and physical environments shared by residents, which in turn operate through more proximate attributes to impact on health outcomes. In effect, public services such as electricity, water, sewerage, transportation and telephone networks are likely to be less adequate in lower socioeconomic communities, with often deleterious consequences on child's health. Analogously, the existence of, quality of, and access to health-related as well as to social and economic services such as schools and markets usually differ by socioeconomic characteristics of communities. Even when these basic services and food may be available in deprived areas, their access may be hampered by barriers such as inadequate or unsafe transportation systems (Mosley and Chen, 1984; Robert, 1999). However, an important critique of cross-sectional studies investigating contextual effects of neighborhood is that people may be selected into communities based on values of the outcome being investigated, especially when the outcome under study or some of its factors may influence where people can or choose to live (Diez-Roux, 2002). It is thus worthwhile mentioning as pointed out by Sastry (1996) that community-level services and infrastructures may be determined endogenously: they may be located in areas of especially high prevalence of ill-health outcomes, or individuals may choose to migrate to communities on the basis of their demand for a particular mix of community services and amenities.

To the best of our knowledge, none of the previous studies especially those focusing on developing countries has actually been conducted to attempt to deal simultaneously with the two issues that we have pinpointed in this paper. Cortinovis et al. (1993) and Durkin et al. (1994) have attempted to draw awareness on the need to construct overall socioeconomic indexes rather than using individual indicators. Their indexes, although not built within a comparative perspective, marked a step

forward in research on SES influences on health. Recent works by the World Bank (Filmer and Pritchett, 1998; 1999; Gwatkin et al., 2000) pioneer the use of asset index to measure household SES from the DHS-like data which do not have direct information on income or expenditures. They construct household wealth index based on indicators of household assets, solving the problem of choosing appropriate weights by allowing them to be determined by the statistical procedure of principal components. Using data that have both assets variables and expenditures, Filmer and Pritchett (1998) showed that *"not only is there a correspondence between a classification of households based on the asset index and consumption expenditures, the evidence is consistent with the asset index being a better proxy for predicting enrolment than consumption expenditures"*. Because the asset index is apparently less subject to measurement errors and has been thought of as a better proxy for the long run household wealth, the household wealth index has been extensively used particularly in studies of socioeconomic inequalities in health in developing countries (Gwatkin et al., 2000; Wagstaff, 2000; 2002; Wagstaff and Watanabe, 2000; Wagstaff et al., 2001).

Departing from Filmer and Pritchett (1998) and Gwatkin et al. (2000), and within the framework developed above recognizing the distinctive feature of socioeconomic indexes measured at the household versus community levels, we construct three relevant and complementary SE indexes for health research in developing countries:

- Household wealth index that expands or may be used as proxy for the commonly used income or expenditures variables, and capturing household's possessions (electricity, radio, TV, refrigerator, bicycle, motorcycle, car, oven, stove, and telephone)[1], type of drinking water source, toilet facilities and flooring material;
- Household social index, that encompasses parental (maternal and paternal) education and occupation; and
- Community endowment index, defined from the proportion of households having access to electricity, telephone and cleaned water, together with relevant community-level information

retrieved from community surveys when available[2]. Understandably, the community endowment index is designed to represent the broad socio-economic ecology of the surrounding area in which families live.

Conceptually, besides distinguishing socioeconomic factors by level of influence, it is of special interest to examine whether health inequalities mainly are the effects of or are mediated by poverty and material hardship on the one hand; or on the other, are primarily due to factors such as education, employment status and other indicators of social status that are likely to causally precede income and wealth (Kawachi et al., 2002; Lynch and Kaplan, 2000; Rahkonen et al., 2002). In effect, the material interpretation of SE inequalities in health emphasises the graded relation between SES and access to tangible material needs, services and amenities such as foods, cleaned water, electricity, and the like. The social interpretation by contrast, pertains to the direct or indirect effects of knowledge and behavior patterns in (re)producing health inequalities. The two household indexes seek to further our understanding of this issue.

3. Data and methods

3.1. Data and selected countries

To test the proposed socioeconomic indices, we use quantitative data from nationally representative Demographic and Health Surveys (DHS) carried out at periodic intervals in developing countries across Asia, Latin America, the former Soviet Union, the Middle East and Africa. We have chosen the following five African countries which have carried out more than one DHS survey in the 90s: Burkina Faso (1992/93, 1998/99); Cameroon (1991, 1998); Egypt (1992, 2000); Kenya (1993, 1998) and Zimbabwe (1994, 1999). The inter-survey intervals are somewhat similar, varying from 5 years for Kenya and Zimbabwe to 8 years for Egypt. From here on and without further qualification, we refer to the first and second surveys in each country as DHS-1 and DHS-2 respectively[3]. It will be particularly interesting to examine whether the relation between SES and

health remained similar, were attenuated or strengthened during the inter-survey periods. Self-explanatory country-specific samples of communities, households and children are in Table I.

Table I
Sample characteristics of Demographic and Health Surveys (DHS) in selected African countries

	Burkina Faso		Cameroon		Egypt		Kenya		Zimbabwe	
	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2
Year of survey	1992/93	1998/99	1991	1998	1992	2000	1993	1998	1994	1999
Communities (1)	76	75	76	76	74	84	83	85	70	70
Households	5 143	4 812	3 538	4 697	10 760	16 957	7 950	8 380	5 984	6 369
Children aged 0 to 5 years	5 828	5 953	3 350	3 933	8 764	11 467	6 115	5 672	4 090	3 643

(1): Constructed by aggregating sampling clusters.

The selected countries exhibit quite different socioeconomic and demographic profiles, with Burkina Faso being one of the least developed country and Egypt by contrast, one of the most affluent. According to the latest population, economic and social indicators from the World Bank (2002), their real Gross Domestic Product (GDP) per capita vary from almost $US 250 in Burkina Faso to $US 1 230 in Egypt, with intermediate values close to $US 330 in Kenya, $US 625 in Zimbabwe and $US 665 in Cameroon. Real GDP per capita for Africa as a whole stands approximately at $US 737.5. With an average value for the continent of almost 38%, urbanization rate also differs significantly among the selected countries, varying from less than 20% in Burkina Faso to almost 50% in Cameroon, with 33-35% in Kenya and Zimbabwe, and 45% in Egypt.

Regarding health status, life expectancy at birth stands at 67 years in Egypt and ranges from 40 years in Zimbabwe to 51 years in Cameroon. Furthermore, illiteracy rate stands at around 40% in Africa as a whole and reaches 77% in Burkina Faso, 45% in Egypt, 25% in Cameroon, close to 20% in Kenya and 12% in Zimbabwe. Primary school gross enrolment ratio stands at 40% in Burkina Faso, 85% in both Cameroon and Kenya, and almost 100% in Egypt and Zimbabwe, with a continental average of 80%. Overall, according to the Human Development Index (HDI), Egypt is ranked at the position 7 (out of a total of 48 African countries); Zimbabwe, Kenya and Cameroon

are in the middle class, ranking 14th, 17th and 18th, respectively. Finally, Burkina Faso lags behind at the 45th position, just before Mozambique, Burundi, Niger and Sierra Leone (UNDP, 2002). Hence, although the selected countries are not representative of the entire African continent, their geographic location (West, Central, North, East and Southern Africa) and socioeconomic and cultural diversities constitute a good yardstick for the continent and may allow us to draw some robust inferences about the accuracy of the proposed indices in this paper in predicting health status from DHS data. Basically, DHS surveys retrieve detailed nutrition and health related information on women aged 15-49 years and births that took place in the three or five years preceding the survey date, along with several individual, household and community characteristics that covary with health and survival statuses.

In the DHS data, socioeconomic indicators concern mainly parental education and occupation, household's ownership of a number of consumer durable items, dwelling characteristics, type of drinking water source and toilet facilities used and other characteristics related to wealth status. Community surveys in some countries also provide information on accessibility of roads, availability of sewerage system and distance to socioeconomic infrastructure such as schools, markets, transportation services, banks, postal services, health services, and pharmacy. These variables are used to create our socioeconomic indices through relevant linear combinations, as described below. In this paper, the health outcomes used in relation to the indices developed here are: (i) health care services utilization proxied by antenatal care and immunization; (ii) childhood malnutrition captured by stunting and underweight; and (iii) infant and child mortality. The definitions and specifications of variables used in the analyses are shown in Table II.

In most previous studies using DHS data, the term community has usually being used to refer either to the type of place of residence (urban community versus rural community), to administrative units (province, district or governorate) or to sampling clusters. We have defined community by grouping

sampling clusters within administrative units[4] in order to have a desirable minimum of 8 households per community and a number of communities totalling a minimum of around 30, for the precision of our estimated parameters. Except for mother's occupation in Burkina Faso (1992/93) and Kenya (1993), they are very few missing data for variables used in the construction of the indices. Missing values are set to zero for discrete variables coded 0-1; for continuous ones, they are assigned to the average value on the preceding and the following clusters[5].

3.2. Methods

The three socioeconomic indexes we have defined at the household and community levels are constructed using Principal Component Analysis (PCA). PCA is a statistical technique that linearly transforms an original set of observed variables into a substantially smaller and more coherent set of uncorrelated variables that capture most of the information through maximizing the variance accounted for in the original variables, thus solving the problem of weights. The technique was originally conceived by Pearson (1901) and independently developed by Hotelling (1933). In the eventuality of multicollinearity threat and subsequent imprecise regression parameters due to highly correlated independent variables or conceptual uncertainties regarding index construction, the PCA method has been shown to have special appeal (Dunteman, 1989; Jolliffe, 1986).

Table II

Definitions and specifications of variables used in the analyses

Variable	Panel A. Dependent variables: Health care service utilisation, early childhood malnutrition, infant and child mortality
1. Health care services utilisation	
1.1. Antenatal care	Dummy variable coded 1 if the child's mother received at least one antenatal care from a medically trained person
1.2. Immunization	Dummy variable coded 1 if the child is fully immunized for his age. We use the following age schedule for infant vaccination derived from the Expanded Program on Immunization set by the WHO (1): BCG at birth; DPT and oral Polio at 2, 3 and 4 months; Measles at 9 months.
2. Early childhood malnutrition	
2.1. Stunting	Dummy variable coded 1 if the child's height measurement in relation to age is more than 2 standard deviations below the (WHO/NCHS/CDC) (1) median reference. The missing values are excluded for the calculations.
2.2. Underweight	Dummy variable coded 1 if the child's weight measurement in relation to age is more than 2 standard deviations below the (WHO/NCHS/CDC) median reference. The missing values are excluded for the calculations.
3. Infant and child mortality	Mortality rates are calculated using synthetic cohort probabilities of death. The probabilities of death are calculated for the following subintervals of exposure: 0 months, 1-2 months, 3-5 months, 6-11 months, 12-23 months, 24-35 months, 36-47 months, 48-59 months. The mortality rates are calculated using the SPSS mortality program provided by Macro International Inc. in its web site. We apply the program for the population as a whole and for each of the index' quantile group (independent variables described below).
3.1. Infant mortality	Infant born in the 5 years preceding the survey who died before their first birthday anniversary
3.2. Under five years mortality	Infant born in the 5 years preceding the survey who died before their fifth birthday anniversary
	Panel B: Independent variables (Socioeconomic indices)
1. Household level	
1.1. Household Wealth index	Constructed from household's ownership of a number of goods (electricity, radio, TV, refrigerator, bicycle, motorcycle, car, oven, stove, and telephone), type of drinking water source, toilet facilities and flooring material. The last three indicators above are recoded 0-1 in terms of access to cleaned water, to modern toilets, to finished floor respectively. Each household is assigned to quantile categories labelled Poorest (lowest 20%), Second, Middle, Fourth and Richest (Top 20%).
1.2. Household Social index	Constructed from a set of dummy variables related to mother and father education and occupation. Education is coded 0 (no education); 1 (primary); and 2 (secondary and more). Occupation is coded 0 (no occupation); 1 (works in the agricultural sector); and 3 (works in the other sectors). Thus, 8 dummy variables are created with 0 as reference category. Each household is assigned to quantile categories labelled as mentioned above.
2. Community level	
Community Endowment index	Constructed from the proportion of households having access to electricity, to telephone, to cleaned water. When community surveys are available (DHS-1 only), relevant variables such as access roads, sewerage system, distances to different socioeconomic infrastructures (schools, markets, regular transportation services, postal services, banks, health services, pharmacy) are also used in the index. Each community is assigned to quantile categories labelled as mentioned above.

(1): World Health Organization; National Center for Health Statistics (USA); Center for Disease Control (USA).

Methodologically, principal components analysis was first used to combine socioeconomic indicators into a single index (Boelhouwer and Stoop, 1999). For instance, acknowledging the inappropriateness of single indicator approaches for studying regional inequalities, Quadrado et al. (2001) use a series of social and economic indicators that are combined into a composite index through Theil's measure of multidimensional inequality and PCA to identify the least-favoured and the most-favoured regions in Hungary. Several other studies have used PCA to construct socioeconomic indices for measuring inequality and uneven development (Boelhouwer and Stoop, 1999; Quadrado et al., 2001; Durkin et al., 1994; Fiadzo et al., 2001; Gwatkin et al., 2000; Filmer and Pritchett, 1998; 1999) and Lai (2003; 2000) recently even improved the UNDP-Human Development Index by using PCA to find an optimal linear combination of the three basic indicators, rather than a simple average, to analyze progress in Chinese provinces (Lai, 2003). Further methodological details are put in Appendix I.

After defining communities, the process of constructing the indices begins with the assessment of correlation among indicators for each of the three socioeconomic indexes. We expect that the indicators should be related to one another empirically, otherwise, it is unlikely that they measure altogether the same concept. However, for the sake of international comparison, we maintain even non-significantly correlated indicators. Practically, the socioeconomic indexes are defined as the first principal component. It is worth noting that whilst the three socioeconomic indexes are continuous with mean value zero by construction, when necessary and particularly for descriptive purposes, households and communities may be assigned to quintiles, the most commonly used being the five 20% quintiles. In this instance, they may be classified hereinafter as Poorest, Second, Middle, Fourth and Richest[6]. Because the methodologies and survey instruments and information in the DHS are almost the same in all participating countries, we may undertake valid comparisons of the results across countries and over time within each country, since indices are constructed using the same method, namely the principal components analysis. Hence, this approach of constructing

socioeconomic indices based on socioeconomic indicators built from weights derived from principal component analysis is of potentially broad applications in developing countries where DHS-type surveys are widespread.

4. Assessing the constructed indices

4.1. Proportion of variance accounted for by the first principal component

As noted above, PCA are designed to produce a linear combination of the indicators which maximally correlates with individual variables, and how much variance is accounted for by the index. Table III displays the basic information regarding the number of indicators and cases used for the PCA, and how well the first component fits the underlying variables through the proportion of the total variation accounted for.

For the household wealth and social indexes, the explained proportion of the variance varies from 28% for the household social index in Burkina Faso (DHS-1) to almost 40% for the household wealth index in Kenya (DHS-1), a variation which is substantial but not overwhelming. Basically, the estimated proportion tends to be higher for household wealth index than for household social index though the latter contains fewer indicators (8). This result suggests that at the household level, wealth index is more accurate than social index in terms of capturing the indicators used in their construction. As regards community endowment index, the proportion of variance explained by the first principal component is strikingly high in the DHS-2, and this may be due at least in part to the fact that in the absence of community surveys, we used only three indicators (e.g., case with Egypt in the DHS-1). In the four other DHS-1 surveys, the proportion remains high, ranging from 39% in Cameroon with 11 indicators to 54% in Zimbabwe with 9 indicators, with 50% in Burkina Faso (9 indicators) and 45% in Kenya (7 indicators). Overall, the three socioeconomic indices expressed as first principal components capture quite well the information conveyed by the indicators used in their construction.

Table III

Factor analysis outputs: Proportion of variance explained by the first principal component

	DHS-1			DHS-2		
	Number of variables used	Proportion of the total variance	Number of cases used	Number of variables used	Proportion of the total variance	Number of cases used
1. Burkina Faso						
Household Wealth index	10	38.0	5 143	11	37.5	4 812
Household Social index	8	27.9	6 354	8	30.0	6 445
Community Endowment index	9	50.2	76	3	88.5	75
2. Cameroon						
Household Wealth index	12	37.1	3 538	12	35.5	4 697
Household Social index	8	29.3	3 871	8	33.8	5 501
Community Endowment index	11	39.2	76	3	71.2	76
3. Egypt						
Household Wealth index	11	38.2	10 760	12	28.3	16 957
Household Social index	8	34.7	9 864	8	33.8	15 573
Community Endowment index	2	79.1	74	3	68.3	84
4. Kenya						
Household Wealth index	8	39.7	7 950	11	36.1	8 380
Household Social index	8	27.8	7 540	8	31.2	7 881
Community Endowment index	7	45.2	83	3	78.7	85
5. Zimbabwe						
Household Wealth index	10	38.6	5 984	11	37.7	6 369
Household Social index	8	30.7	6 128	8	32.5	5 907
Community Endowment index	9	54.2	70	3	82.1	70

4.2. Internal coherence and robustness of the indices

We expect each socioeconomic index to be internally coherent, that is, to produce sharp separations across its quintile groups for each of the indicator used in its construction. Table IV illustrates the general pattern of findings using the estimates for the household wealth index. To ease comparisons while avoiding clutter, three quintiles groups are designed: lowest 30%, middle 40% and top 30%[7]. As can be observed in Table IV, household wealth index produces very clear differences across the three quintiles groups. In Burkina Faso for example, households from the lowest 30% have access to almost none of the assets involved in the index, except for bicycle which emerges as an indicator of poverty. Furthermore, households from the middle 40% have limited access to wealth assets. At the other extreme, in Egypt the separation is also visible though less marked as the country enjoys a high overall economic situation. For instance, for DHS-1 (1992) of Egypt, the frequency of cleaned water among Egyptian households ranged from 51% in the lowest 30% to almost 100% in the top 30% with 83% in the middle 40%, with a national average of 75%. For DHS-2 (2000) of Egypt, the figures for cleaned water are similar, standing at around 71% (lowest 30%), 90% (middle 40%), and 99% (top 30%) and 86% (national average).

More generally this pattern clearly holds for almost all the countries and periods and all the wealth assets, indicating a high degree of reliability of the socioeconomic indices used here for summarizing information contained in the assets variables. Similar findings are noted for the household social index and the community endowment index (not shown, available upon request). These findings are indeed robust in the sense that each index produces similar classification of households or communities within quintiles, when different subsets of indicators are used in its construction. Tests for robustness were performed only in Cameroon for wealth index, using two subsets of indicators and were satisfactory (results no shown, available upon request).

Table IV

Internal coherence of Household wealth index: Average asset ownership across wealth quintile groups

	DHS-1				DHS-2			
	Bottom 30%	Middle 40%	Top 30%	Overall	Bottom 30%	Middle 40%	Top 30%	Overall
1. Burkina Faso								
Electricity	0.0	0.0	14.5	4.8	0.0	0.0	17.5	4.1
Radio	0.0	53.9	90.8	52.0	0.0	90.2	88.2	63.1
Television	0.0	0.0	11.1	3.6	0.0	0.0	20.1	4.8
Refrigerator	0.0	0.0	5.4	1.8	0.0	0.0	8.1	1.9
Bicycle	100.0	64.9	72.9	76.7	76.7	95.2	80.3	86.2
Motorcycle	0.0	7.5	85.0	31.0	0.0	29.1	55.2	26.7
Car	0.0	0.0	5.6	1.9	0.0	0.0	7.7	1.8
Telephone	na	na	na	na	0.0	0.0	4.2	1.0
Cleaned water	0.0	4.3	37.6	14.1	0.0	0.0	39.9	9.5
Modern toilets	0.0	0.0	3.0	1.0	0.0	0.0	2.4	0.6
Finished floor	0.0	17.8	61.2	27.4	0.0	5.7	89.2	23.8
2. Cameroon								
Electricity	0.0	6.6	85.9	31.5	0.0	27.4	93.1	37.5
Radio	16.7	66.8	92.9	62.5	10.1	67.3	87.4	56.0
Television	0.0	0.5	57.6	19.6	0.0	2.6	63.1	18.6
Refrigerator	0.0	0.0	37.3	12.5	0.0	0.8	32.1	9.3
Bicycle	32.7	18.9	7.7	18.7	31.4	11.9	10.1	17.1
Motorcycle	0.0	13.6	19.4	12.0	2.8	10.4	21.4	11.2
Car	0.0	0.2	21.3	7.3	0.0	0.8	17.5	5.2
Telephone	na	na	na	na	0.0	0.0	6.5	1.8
Oven	0.0	0.0	30.4	10.2	na	na	na	na
Stove	0.0	4.3	25.6	10.3	0.0	10.7	64.2	22.3
Cleaned water	0.0	27.4	79.5	37.8	2.1	27.9	72.6	32.7
Modern toilets	0.0	32.9	86.3	42.3	0.0	15.1	71.1	26.1
Finished floor	0.0	32.5	94.0	44.7	0.0	32.1	95.4	40.2
3. Egypt								
Electricity	79.7	99.5	100.0	92.3	92.0	100.0	100.0	97.3
Radio	32.1	67.5	98.0	61.5	52.6	93.9	99.8	81.2
Television	46.2	88.5	99.6	75.5	71.8	98.7	99.7	89.7
Refrigerator	4.6	61.7	99.8	49.4	9.7	80.0	99.9	60.9
Bicycle	7.7	15.5	18.9	13.4	6.5	14.4	32.0	16.2
Car/motorcycle	1.2	2.3	17.3	5.3	na	na	na	na
Motorcycle/scoote	na	na	na	na	0.4	1.0	6.0	2.1
Car/Truck	na	na	na	na	1.5	2.9	23.5	7.6
Telephone	na	na	na	na	0.5	6.5	74.2	21.6
Electric fan	10.9	47.1	98.6	45.5	28.3	83.7	99.7	68.7
Gas/electric stove	3.2	58.4	99.6	47.5	na	na	na	na
Cleaned water	51.0	83.3	99.8	75.2	71.2	89.8	98.6	85.7
Modern toilets	34.4	83.3	100.0	69.1	79.3	99.7	100.0	92.8
Finished floor	12.9	76.5	98.9	58.3	40.7	89.1	99.5	75.1

Table IV (Continued)

Internal coherence of Household wealth index: Average asset ownership across wealth quintile groups

	DHS-1				DHS-2			
	Bottom 30%	Middle 40%	Top 30%	Overall	Bottom 30%	Middle 40%	Top 30%	Overall
4. Kenya								
Electricity	0.0	0.0	28.1	7.1	0.0	0.1	41.7	10.2
Radio	0.0	72.2	84.0	54.9	0.0	85.9	92.6	65.6
Television	0.0	0.0	18.5	4.6	0.0	0.0	49.8	12.1
Refrigerator	0.0	0.0	8.0	2.0	0.0	0.0	9.8	2.4
Bicycle	0.0	41.7	32.5	27.7	16.5	34.8	32.6	29.6
Motorcycle	na	na	na	na	0.0	0.0	4.3	1.0
Car	na	na	na	na	0.0	0.0	12.9	3.1
Telephone	na	na	na	na	0.0	0.0	6.5	1.6
Cleaned water	0.0	23.7	60.7	26.4	0.0	19.6	70.6	27.0
Modern toilets	0.0	1.4	47.1	12.5	0.0	2.1	54.1	14.2
Finished floor	0.0	3.7	88.1	23.9	0.0	15.9	84.9	28.6
5. Zimbabwe								
Electricity	0.0	1.4	89.9	23.0	0.0	16.4	95.5	33.0
Radio	19.5	42.7	82.1	44.7	19.4	51.0	91.8	51.5
Television	0.0	1.4	55.3	14.4	0.0	7.5	71.3	22.8
Refrigerator	0.0	0.0	28.1	7.0	0.0	0.6	40.9	11.7
Bicycle	8.1	23.7	24.8	18.7	9.8	32.3	21.2	21.3
Motorcycle/scoote	0.0	0.1	1.3	0.4	0.0	0.8	1.7	0.8
Car/truck	0.0	0.7	19.2	5.1	0.0	1.2	17.6	5.4
Telephone	na	na	na	na	0.0	0.5	16.5	4.8
Cleaned water	0.0	29.2	93.5	35.4	3.7	37.3	93.0	41.3
Modern toilets	0.0	53.8	97.3	46.6	9.0	64.8	98.6	54.9
Finished floor	0.0	63.4	97.5	50.5	19.0	85.9	98.6	66.2

na: Not applicable.

5. Socioeconomic indices, health-seeking behaviour, health and nutritional status in Africa

Having constructed the socioeconomic indexes, we now examine their associations with selected health outcomes: health care service utilisation, malnutrition and mortality among under-five children. The relationships between each of the three socioeconomic indexes and the six health outcomes are shown in Tables V to VII and illustrated in figures 1 to 3. In general, estimates exhibit remarkable socioeconomic gradients in each country and period of observation: women from wealthier socioeconomic quintile groups have a higher probability of seeking health care services, their children are less likely to be undernourished and ultimately more likely to survive, compared with their counterparts in the lower socioeconomic quintile groups. We illustrate further this general pattern of the association between each socioeconomic index and the outcome variables by using the "*poor/rich ratio*"[8] as a proxy of socioeconomic gradient and as an indicator of socioeconomic inequalities[9].

Obviously, poor/rich ratio is a crude index since, among other things, it unveils no information regarding the middle three quintiles as could be the case with more complex analysis using concentration curves and indices as described by Wagstaff et al. (1991) and Kakwani et al. (1997). However, the poor/rich ratio provides a fairer means of assessing a general order of magnitude of differences between the poorest and the richest groups of the population. We expect poor/rich ratio to be less than unity for health care service utilisation, and to be superior to unity for ill-health outcomes, namely malnutrition and mortality. Comparing these ratios in the DHS-1 and DHS-2 in each country may yield some insights about the changes over time in health inequalities between socioeconomic groups, and deepen our understanding of how such inequalities may get worse, remain the same, or improve over time (Feachem, 2000). Hence, the further the poor/rich ratio from unity, the wider the inequalities between the poorest and the richest quintile groups.

Table V

Household Wealth Status and Health Outcomes in Africa

	Health service utilisation (1)				Nutritional status of children (1)				Infant and child mortality				Births in the 5 years preceding the survey	
	Antenatal care		Immunization		Stunting		Underweight		IMR (2)		U5MR (3)			
	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2
1. Burkina Faso														
Poorest	45.1	50.3	44.4	37.2	36.0	44.1	35.9	39.7	101.2	118.9	208.7	261.4	1 221	1 271
Second	47.1	47.7	42.0	40.5	37.6	34.7	36.7	34.8	125.1	140.9	230.8	310.1	507	406
Middle	54.7	54.1	48.0	41.6	37.0	39.6	34.9	37.6	107.4	108.1	224.0	240.3	1 028	1 675
Fourth	63.1	66.8	52.6	45.8	35.2	36.4	34.0	34.0	98.3	113.4	218.7	250.5	1 240	1 407
Richest	86.1	85.1	65.0	58.7	23.3	26.5	24.5	25.5	61.9	75.5	138.1	162.1	1 832	1 194
Overall	59.4	60.5	50.7	44.1	33.5	37.1	32.9	34.8	96.6	109.2	202.2	240.5	5 828	5 953
2. Cameroon														
Poorest	49.9	58.7	29.5	32.3	34.2	38.7	24.6	34.9	91.0	119.6	181.3	227.1	598	894
Second	75.8	72.4	34.6	33.5	33.9	30.9	16.8	24.2	73.2	79.5	156.5	178.8	417	526
Middle	78.7	80.8	38.0	41.5	36.1	32.8	19.6	21.7	67.5	58.9	132.6	136.6	592	800
Fourth	87.4	91.4	54.5	54.4	21.3	26.1	12.5	17.3	55.4	67.3	119.6	142.9	668	766
Richest	97.8	95.1	70.3	63.7	12.3	16.7	6.8	10.1	44.1	54.8	78.8	96.6	1 075	947
Overall	77.9	78.3	46.2	44.2	26.2	29.8	15.2	22.6	65.6	78.9	131.6	160.3	3 350	3 933
3. Egypt														
Poorest	33.5	32.6	58.6	89.4	33.8	25.8	14.1	6.5	85.4	54.9	126.5	69.3	2 142	2 568
Second	41.6	41.7	67.6	92.2	30.2	21.6	10.7	4.5	69.7	53.7	100.6	69.0	2 231	2 613
Middle	57.1	54.1	77.5	92.2	25.1	17.0	10.6	3.1	59.4	35.1	77.8	44.4	1 722	1 165
Fourth	69.6	61.7	80.6	93.7	19.0	15.8	6.5	3.1	44.9	42.0	57.9	52.2	837	2 894
Richest	77.7	79.1	87.3	94.4	16.9	12.7	5.6	2.7	38.8	26.3	50.0	30.9	1 832	2 227
Overall	52.9	52.9	72.7	92.4	26.2	18.9	10.0	4.1	62.6	44.0	87.6	55.3	8 764	11 467
4. Kenya														
Poorest	90.6	86.0	73.6	59.6	40.5	41.0	28.6	31.1	82.5	90.3	127.2	144.2	1 757	1 265
Second	95.9	90.9	76.3	63.9	37.3	32.7	23.1	24.0	88.5	85.9	142.4	137.9	331	1 338
Middle	96.5	92.4	79.6	64.4	34.2	34.5	23.4	25.0	57.5	87.3	94.1	125.4	1 989	1 318
Fourth	96.1	94.2	84.6	71.7	31.4	26.6	20.3	14.3	54.4	58.3	83.6	89.2	1 220	1 014
Richest	96.5	96.3	87.9	65.5	19.8	16.5	12.9	9.5	39.0	39.9	63.5	60.3	818	737
Overall	94.7	91.5	79.8	64.6	33.7	31.4	22.8	21.9	62.9	75.5	99.8	116.5	6 115	5 672
5. Zimbabwe														
Poorest	91.5	66.7	73.2	71.5	22.0	35.1	17.2	20.2	56.7	62.0	87.8	115.9	1 053	949
Second	91.7	69.7	75.8	69.8	27.3	27.1	20.6	14.2	41.9	65.6	75.1	117.2	895	941
Middle	94.4	72.2	78.8	68.8	23.1	25.8	14.7	13.2	60.4	73.3	76.5	108.4	871	694
Fourth	95.4	76.1	82.8	70.4	21.3	25.1	15.0	10.4	65.5	72.7	88.8	107.2	575	518
Richest	96.4	81.4	88.8	76.0	12.8	18.4	9.8	6.3	47.1	60.0	66.8	78.0	696	541
Overall	93.6	72.7	79.3	71.2	21.6	27.0	15.7	13.4	53.7	66.4	79.4	106.2	4 090	3 643

(1): For Cameroon-DHS-2, Kenya-DHS-2 and Zimbabwe-DHS-1, maternal and child health as well as nutritional statust of children are observed for children aged 0 to 3 years;
(2): Infant mortality rate; (3): Under five years mortality rate.

Table VI

Household Social Status and Health Outcomes in Africa

	Health service utilisation (1)				Nutritional status of children (1)				Infant and child mortality				Births in the [illegible]rs preceding the survey	
	Antenatal care		Immunization		Stunting		Underweight		IMR (2)		U5MR (3)			
	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2
1. Burkina Faso														
Poorest	47.0	46.9	45.0	40.5	38.9	39.4	35.2	37.7	92.1	147.2	187.1	292.4	1 372	1 348
Second	48.7	55.2	47.4	39.9	34.7	36.9	35.2	36.2	101.3	110.3	247.9	260.6	410	1 275
Middle	53.4	59.5	47.8	42.0	37.1	40.1	36.4	36.2	111.4	97.1	233.2	229.1	1 312	1 418
Fourth	70.6	70.5	52.6	47.2	30.7	36.1	33.1	30.3	90.4	87.9	186.4	206.7	1 169	744
Richest	84.0	84.0	65.6	57.4	21.2	30.7	22.2	29.9	84.5	86.0	170.5	178.9	1 565	1 168
Overall	59.4	60.5	50.7	44.1	33.5	37.1	32.9	34.8	96.6	109.2	202.2	240.5	5 828	5 953
2. Cameroon														
Poorest	55.2	59.1	28.1	32.6	36.1	34.5	21.2	28.2	78.8	102.7	168.2	213.3	537	839
Second	70.0	75.8	39.0	40.6	34.4	32.9	20.9	28.3	87.7	73.1	174.9	155.9	613	700
Middle	81.0	81.2	44.7	44.7	24.0	30.9	13.6	24.2	57.3	84.6	115.9	155.0	620	765
Fourth	91.1	89.4	54.4	49.0	23.0	26.0	12.2	15.9	56.0	74.9	116.1	157.3	708	866
Richest	94.4	94.1	66.4	60.8	15.4	21.2	9.0	12.0	45.5	43.5	75.6	90.7	872	763
Overall	77.9	78.3	46.2	44.2	26.2	29.8	15.2	22.6	65.6	78.9	131.6	160.3	3 350	3 933
3. Egypt														
Poorest	33.4	33.8	60.8	90.4	33.2	22.3	13.2	4.7	75.1	51.6	116.9	67.4	2 188	2 465
Second	48.7	41.4	70.8	92.3	26.6	21.8	11.3	4.5	73.9	53.5	91.5	69.4	1 533	1 869
Middle	47.6	47.8	70.9	91.6	30.3	21.1	10.4	5.3	64.0	48.3	90.7	62.0	1 875	2 200
Fourth	62.2	66.6	80.1	93.6	21.5	14.7	8.6	3.1	56.3	34.7	79.4	40.1	1 547	3 812
Richest	81.3	79.2	86.0	94.2	15.6	16.7	5.1	2.8	38.3	32.9	44.9	37.4	1 621	1 121
Overall	52.9	52.9	72.7	92.4	26.2	18.9	10.0	4.1	62.6	44.0	87.6	55.3	8 764	11 467
4. Kenya														
Poorest	93.7	88.8	73.9	59.5	39.6	39.5	29.1	29.3	85.9	92.4	127.5	139.7	1 460	1 365
Second	95.1	87.8	76.8	62.9	38.7	36.6	25.8	29.1	55.5	80.6	99.1	137.1	1 280	1 118
Middle	93.0	93.0	78.0	65.0	37.4	33.8	25.8	23.4	64.1	85.7	106.0	131.3	1 116	1 168
Fourth	93.6	93.2	83.0	67.6	27.9	26.4	18.6	15.3	59.6	64.3	92.4	97.2	1 227	1 144
Richest	98.7	96.1	89.5	70.4	23.4	16.6	13.4	9.3	43.9	45.1	66.5	62.9	1 032	877
Overall	94.7	91.5	79.8	64.6	33.7	31.4	22.8	21.9	62.9	75.5	99.8	116.5	6 115	5 672
5. Zimbabwe														
Poorest	92.0	65.5	75.8	69.7	24.3	32.5	17.9	19.5	59.8	83.3	80.5	123.6	1 110	879
Second	92.1	69.8	73.4	67.3	26.2	32.1	15.8	16.4	54.5	61.7	89.7	116.4	790	784
Middle	91.2	71.2	75.3	71.1	26.2	25.4	23.1	13.9	54.9	69.4	83.2	108.5	798	819
Fourth	97.1	79.9	83.6	75.5	20.1	20.7	13.9	8.7	43.9	66.7	68.7	94.2	709	527
Richest	96.0	79.7	88.6	73.8	10.6	21.7	7.5	6.9	52.3	50.0	71.2	84.6	683	634
Overall	93.6	72.7	79.3	71.2	21.6	27.0	15.7	13.4	53.7	66.4	79.4	106.2	4 090	3 643

(1): For Cameroon-DHS-2, Kenya-DHS-2 and Zimbabwe-DHS-1, maternal and child health as well as nutritional statust of children are observed for children aged 0 to 3 years;
(2): Infant mortality rate; (3): Under five years mortality rate.

Table VII

Community Endowment Status and Health Outcomes in Africa

	Health service utilisation (1)				Nutritional status of children (1)				Infant and child mortality				Births in the 5 years preceding the survey	
	Antenatal care		Immunization		Stunting		Underweight		IMR (2)		U5MR (3)			
	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2	DHS-1	DHS-2
1. Burkina Faso														
Poorest	34.7	58.7	45.2	44.4	41.5	39.9	37.4	37.2	109.2	121.9	236.1	267.1	1 081	3 446
Second	55.3	58.7	46.4	44.4	35.1	39.9	30.8	37.2	107.5	121.9	214.2	267.1	921	(4)
Middle	50.8	40.2	43.8	26.2	36.2	42.3	36.2	32.9	95.8	105.4	205.8	192.5	1 029	366
Fourth	78.4	57.8	55.0	39.7	30.8	33.7	35.8	35.1	92.6	91.7	196.6	221.3	994	1 281
Richest	95.1	96.6	72.2	67.6	18.7	23.3	19.7	21.6	65.0	68.8	131.4	143.2	1 803	860
Overall	59.4	60.5	50.7	44.1	33.5	37.1	32.9	34.8	96.6	109.2	202.2	240.5	5 828	5 953
2. Cameroon														
Poorest	63.5	74.0	26.5	29.4	32.6	35.1	19.6	29.3	100.4	93.9	183.2	179.6	400	661
Second	71.3	51.0	29.6	30.4	35.0	35.3	17.5	32.6	46.9	97.1	150.6	220.3	430	670
Middle	65.4	78.2	45.3	44.1	29.2	31.3	18.9	22.5	68.3	95.7	141.2	178.5	469	599
Fourth	79.2	93.2	47.4	56.3	32.0	26.8	18.2	15.1	63.4	50.5	115.3	110.4	628	794
Richest	95.7	93.1	65.5	59.0	12.5	19.6	7.7	12.6	58.5	61.7	102.8	121.0	1 423	1 209
Overall	77.9	78.3	46.2	44.2	26.2	29.8	15.2	22.6	65.6	78.9	131.6	160.3	3 350	3 933
3. Egypt														
Poorest	41.8	38.5	58.8	90.1	30.3	28.1	13.8	5.9	81.0	54.9	118.7	70.1	2 722	3 274
Second	42.5	42.6	75.6	92.5	30.6	15.7	10.3	3.8	71.9	41.2	102.3	52.0	2 029	2 641
Middle	57.9	57.2	73.6	93.8	23.6	20.7	8.2	3.8	45.8	48.6	60.9	61.3	1 587	2 010
Fourth	68.8	70.3	88.2	93.7	21.6	12.3	6.1	2.4	47.3	27.2	66.2	35.0	1 096	1 709
Richest	74.2	77.4	85.6	93.8	16.7	11.0	6.3	3.0	41.2	38.3	50.2	43.9	1 330	1 833
Overall	52.9	52.9	72.7	92.4	26.2	18.9	10.0	4.1	62.6	44.0	87.6	55.3	8 764	11 467
4. Kenya														
Poorest	94.0	87.7	77.0	56.4	37.0	35.1	25.5	28.5	92.0	123.3	141.7	184.4	1 581	1 257
Second	93.2	91.2	77.5	64.8	33.1	34.2	20.6	24.4	67.9	71.5	102.1	112.0	1 118	2 125
Middle	95.3	94.1	80.7	71.5	35.4	30.0	26.2	18.4	45.7	40.8	78.3	66.7	2 326	1 392
Fourth	96.1	93.4	82.5	68.9	29.2	25.6	17.6	13.7	44.2	52.1	69.4	67.3	656	532
Richest	96.7	95.7	88.9	67.5	22.2	19.4	13.2	10.7	51.0	58.1	91.3	110.8	434	366
Overall	94.7	91.5	79.8	64.6	33.7	31.4	22.8	21.9	62.9	75.5	99.8	116.5	6 115	5 672
5. Zimbabwe														
Poorest	92.5	71.0	74.5	72.6	23.9	28.9	17.1	16.1	57.5	52.0	84.2	90.0	1 117	1 311
Second	93.3	67.0	76.6	67.0	21.9	30.5	17.5	16.2	59.6	84.0	86.6	143.3	1 215	1 072
Middle	93.6	75.7	81.8	73.4	24.3	26.3	15.5	10.5	46.5	69.3	70.9	100.9	966	620
Fourth	96.3	75.5	85.8	73.3	21.0	20.2	14.3	9.4	48.6	60.0	66.9	73.0	360	384
Richest	94.6	85.6	86.2	72.9	10.5	19.2	10.1	5.4	48.7	60.9	70.2	97.5	432	256
Overall	93.6	72.7	79.3	71.2	21.6	27.0	15.7	13.4	53.7	66.4	79.4	106.2	4 090	3 643

(1): For Cameroon-DHS-2, Kenya-DHS-2 and Zimbabwe-DHS-1, maternal and child health as well as nutritional statust of children are observed for children aged 0 to 3 years;
(2): Infant mortality rate; (3): Under five years mortality rate; (4): Pooled first and second quantile groups.

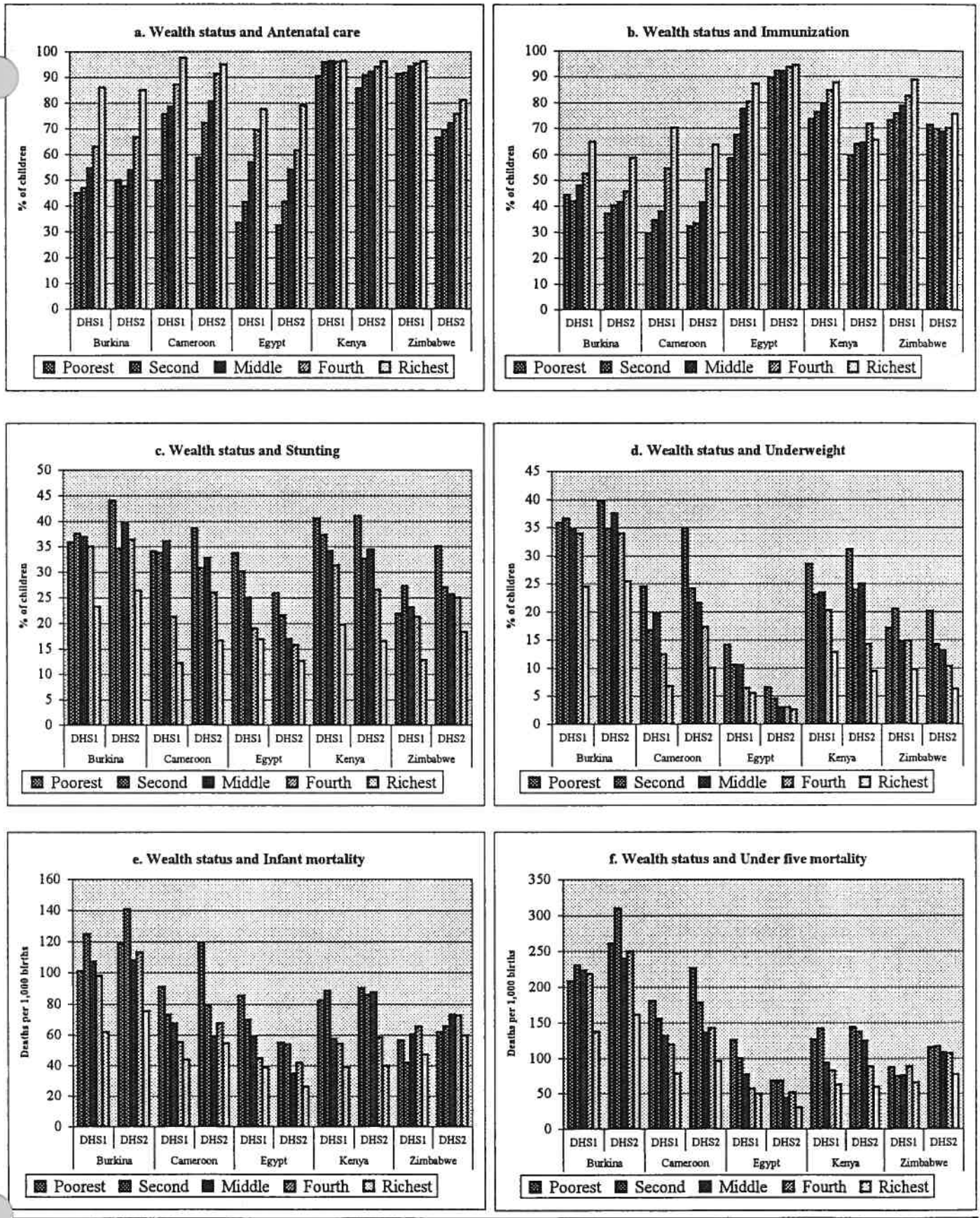

Figure 1. Household wealth status and health outcomes in Africa

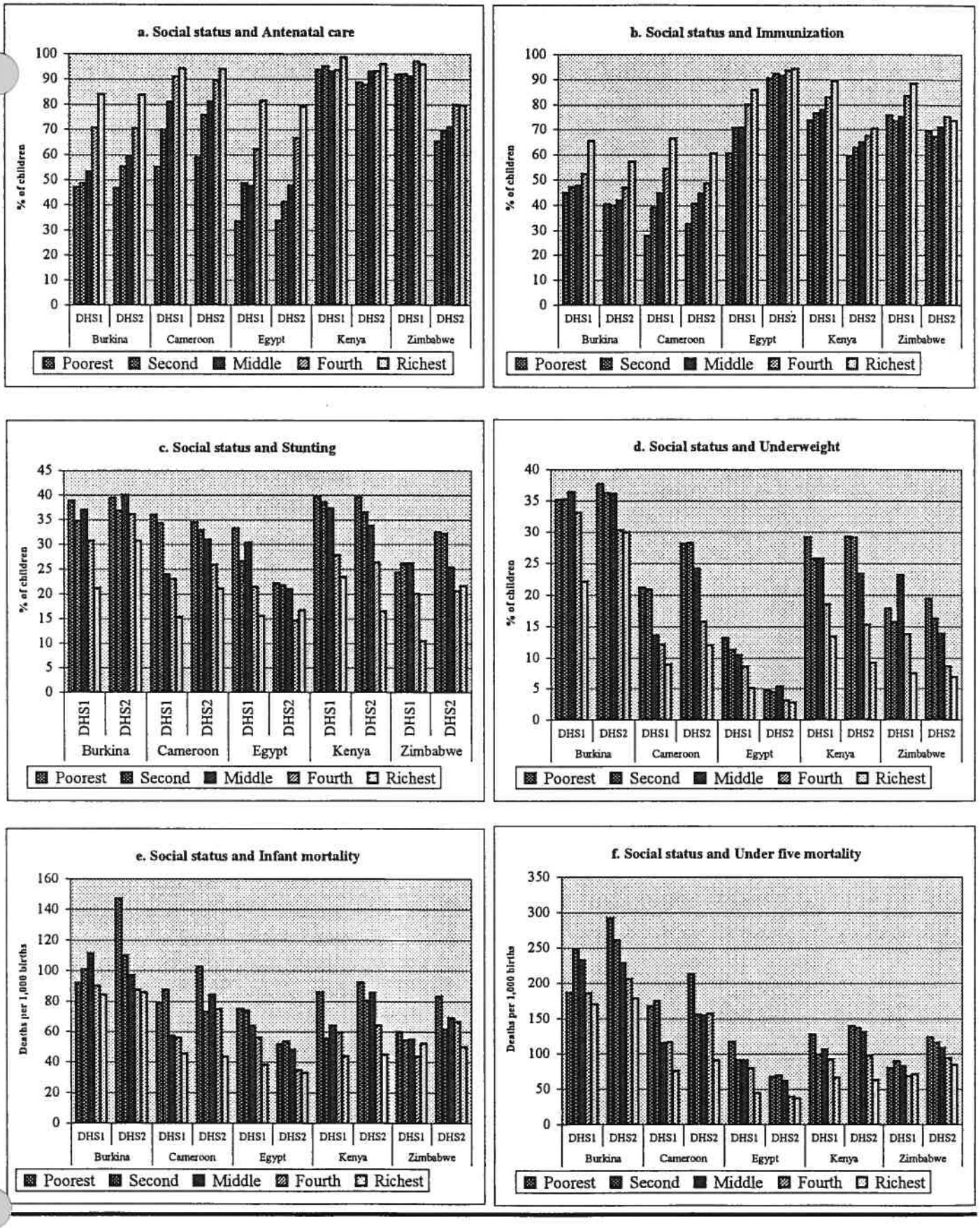

Figure 2. Household social status and health outcomes in Africa

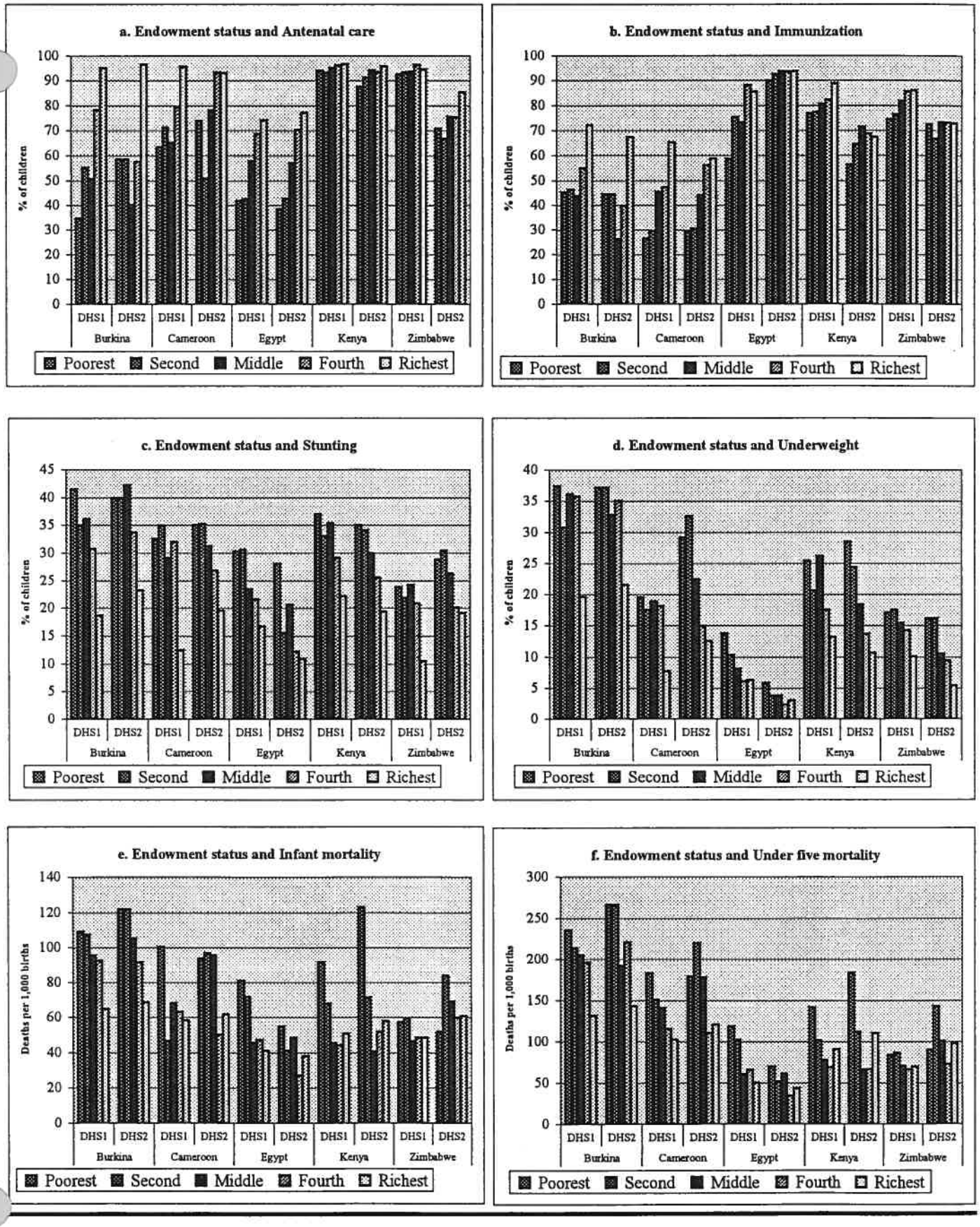

Figure 3. Community endowment status and health outcomes in Africa

5.1. Household wealth index and health outcomes

Table V shows the relationship between household wealth index and the six selected health outcomes. As expected, in all the countries and periods considered, the poor/rich ratio is less than unity for health care services utilisation, whereas for malnutrition and mortality it is higher than unity, indicating that compared to those from the poorest quintile group, mothers from the highest 20% quintile group are more likely to seek antenatal care, that their children have higher chance to be fully immunized, and are in the meantime less likely to be stunted, underweight, or to die. Concerning antenatal care, the poor/rich ratio is very high (close to or higher than 0.80) in Kenya and Zimbabwe, due in part to the overall high frequency of antenatal care in these two countries. Socioeconomic inequalities have tended to decline in Cameroon and Burkina Faso as poor/rich ratio varied from 0.51 to 0.62 in the former and from 0.52 to 0.59 in the latter. In contrast, inequalities in health care service utilisation widened in Zimbabwe along with a sharp decline of the overall frequency of antenatal care attendance of almost 22%. As regards immunization, poor/rich ratio rose by almost 41% in Egypt, indicating a marked decline of socioeconomic inequalities along with an increase of the overall frequency of immunization. The ratio also increased in Cameroon (21%) and in Zimbabwe (14%) along with a sharp decline of the overall proportion of fully immunized children. In Burkina Faso and Kenya, the overall proportion of fully immunized children fell sharply in the inter-survey period, with less evidence of change in socioeconomic inequalities. These associations are depicted in Figure 1.

It appears from Table V that inequalities in childhood malnutrition have dramatically narrowed by 16% in Cameroon for stunting, coupled with an increase of 14% of the overall prevalence of stunting. In contrast, inequalities have worsened in both Kenya and Zimbabwe for both stunting and underweight, along with a sizeable increase of the overall prevalence of malnutrition. For example in Zimbabwe, poor/rich ratio for underweight stands at 1.74 in 1994 with frequency of underweight reaching 9.8% and 17.2% in the richest and poorest groups respectively; and at 3.24 by 1999 with

the frequency of underweight estimated at 6.2% and 20.2% in the richest and poorest groups respectively; these results indicate an increase of socioeconomic inequalities of almost 86% during the inter-survey period. The rate of increase in socioeconomic inequalities stands at 48% for underweight in Kenya and at 25% and 21% for stunting in Zimbabwe and Kenya respectively.

Regarding infant and child mortality, Table V shows that socioeconomic differentials in infant mortality have noticeably declined in Zimbabwe, with poor/ratio varying from 1.21 in 1994 to 1.03 in 1999, and have recorded little change worth of notice over time in the four other countries despite marked fluctuations in the overall infant mortality rate (-30% in Egypt; +20% in Cameroon and Kenya; +13% in Burkina Faso). By contrast, under-five mortality displays a somewhat different feature. Socioeconomic inequalities declined in Egypt by almost 11%, along with a tremendous fall of the overall under-five mortality rate (-37%), and increased markedly in Kenya and Zimbabwe (+19% and +13% respectively) along with a sharp increase in the overall mortality rate (+17% and +34% respectively). Though Cameroon and Burkina Faso did not record significant changes in socioeconomic differentials, their overall under-five mortality rate rose substantially by almost 20%. Figure 1 illustrates these differentials.

5.2. Household social status and health outcomes

Table VI presents estimates of the relationship between household social status and the selected health outcomes. The poor/rich ratio is less than unity for health care services utilisation and is higher than unity for malnutrition and mortality. Household social inequalities in antenatal care have dramatically increased in Zimbabwe, varying from 0.96 in 1994 to 0.82 in 1999, along with a sharp decline of the overall frequency of antenatal care during the inter-survey period. On the contrary, inequalities regarding immunization have narrowed in Egypt between 1992 and 2000 (increase of +36% in poor/rich ratio) along with an overall increase of the proportion of immunized children, in Cameroon (+27%) between 1991 and 1998 and in Zimbabwe (+ 11%) between 1994

and 1999, along with a decline in the overall proportion of immunization. With regard to childhood malnutrition, household social inequalities in childhood stunting have widened in Kenya (+41%) during the inter-survey period, and substantially narrowed in Burkina Faso (-30%), Cameroon (-30%), Zimbabwe (-35%) and Egypt (-37%), along with increasing malnutrition prevalence except for the latter country. The patterns for underweight are to some extent similar to those of stunting, with the exception of Zimbabwe where household social inequalities have worsened and to a lesser extent for Cameroon where inequalities have remained at the same level between the two surveys.

Finally, with respect to mortality, Table VI reveals that social differentials in infant mortality have noticeably widened during the inter-survey period in Burkina Faso and Zimbabwe, both for infant mortality (+57% and +46% respectively) and under-five mortality (+49% and +29% respectively). In contrast, social inequalities have declined sharply in Egypt, both for infant mortality (-20%) and under-five five mortality (-31%). In Cameroon, they worsened for infant mortality (+36%) and remained relatively stable for under-five mortality, whereas they widened noticeably in Kenya for under-five and remained stable for infant mortality. These associations are illustrated in Figure 2.

5.3. Community endowment index and health outcomes

Table VII and Figure 3 portray the relationship between community endowment index and the selected health outcomes. The poor/rich ratio is generally in the expected direction. More specifically, for health care service utilisation, community socioeconomic inequalities in antenatal care have dramatically narrowed in Burkina Faso and Cameroon with poor/rich ratio increasing by 66% and 20% respectively; and have by contrast widened in Zimbabwe (-15%) and in Egypt (-11%). For immunization, the community socioeconomic differentials have generally narrowed between DHS-1 and DHS-2 in Cameroon (+24%), Egypt (+40%) and Zimbabwe (+15%). With regard to malnutrition, community socioeconomic inequalities in stunting during the inter-survey period have narrowed in Burkina Faso (-20%), Cameroon (-27%), and Zimbabwe (-34%), whereas

they have markedly increased in Egypt (+42%). For underweight, those inequalities have dramatically worsened in Zimbabwe (+69%) and Kenya (+36%), in contrast to Egypt (-12%). Finally, from Table VII, community socioeconomic inequalities in mortality sharply declined between DHS-1 and DHS-2 in Cameroon, Egypt and Zimbabwe, both for infant mortality (-11%; -27% and -28%, respectively) and under-five mortality (-17%; -32% and -23%, respectively). By contrast, Kenya recorded an increase in inequalities regarding infant mortality (+18%).

6. Conclusion

This paper has demonstrated the distinctive contributions of socioeconomic indexes measured at the household versus community level in understanding inequalities in health and survival. In doing so, it has underlined the importance of going beyond the purely economic view of socioeconomic status to cover the multi-dimensional as well as multilevel concept of economic and social inequality. The three socioeconomic indexes we have proposed are constructed from almost the same indicators across all countries and over time, and are quite robust for making comparisons across countries and within countries over time, even though it entails a lack of discrimination with respect to the indicators' differing nature or to country-specific realities (Gwatkin et al, 2000).

The association of the three socioeconomic indices with selected health outcomes shows important features of the social and socioeconomic inequalities in health status between and within countries in Africa. The larger the inequalities, the bigger the role that improving health conditions of the poor will play in the overall strategy to improve the health of the populations. Most findings are consistent with expectations regarding the relationships between SES and health outcomes in Africa (Gwatkin et al., 2000; Kakwani et al., 1997; Wagstaff et al., 1991; Kuate-Defo and Diallo, 2002) and one of the key advantages of the poor/rich ratio used here is that it is readily comprehensible by policy-makers.

Table VIII

Relative Change (1) in the Health Outcomes levels and poorest/richest gaps (2) between the two time periods

	Antenatal care				Immunization				Stunting				Underweight				IMR (3)				U5MR (4)			
	DHS-1	DHS-2	% (1)	Trend	DHS-1	DHS-2	% (1)	Trend	DHS-1	DHS-2	% (1)	Trend	DHS-1	DHS-2	% (1)	Trend	DHS-1	DHS-2	% (1)	Trend	DHS-1	DHS-2	% (1)	Trend
Panel A: Relative change in the overall rates between the two time periods																								
1. Burkina Faso	59.4	60.5	2	→	50.7	44.1	-13	↘	33.5	37.1	11	↗	32.9	34.8	6	↗	96.6	109.2	13	↗	202.2	240.5	19	↗
2. Cameroon	77.9	78.3	0	→	46.2	44.2	-4	→	26.2	29.8	14	↗	15.2	22.6	49	↗	65.6	78.9	20	↗	131.6	160.3	22	↗
3. Egypt	52.9	52.9	0	→	72.7	92.4	27	↗	26.2	18.9	-28	↘	10.0	4.1	-59	↘	62.6	44.0	-30	↘	87.6	55.3	-37	↘
4. Kenya	94.7	91.5	-3	→	79.8	64.6	-19	↘	33.7	31.4	-7	↘	22.8	21.9	-4	→	62.9	75.5	20	↗	99.8	116.5	17	↗
5. Zimbabwe	93.6	72.7	-22	↘	79.3	71.2	-10	↘	21.6	27.0	25	↗	15.7	13.4	-15	↘	53.7	66.4	24	↗	79.4	106.2	34	↗
Panel B: Relative change in the poorest/richest household wealth gaps between the two time periods (5)																								
1. Burkina Faso	-0.48	-0.41	-14	↘	-0.32	-0.37	16	↗	0.54	0.67	22	↗	0.46	0.56	21	↗	0.64	0.58	-9	↘	0.51	0.61	20	↗
2. Cameroon	-0.49	-0.38	-22	↘	-0.58	-0.49	-15	↘	1.79	1.32	-26	↘	2.63	2.47	-6	↘	1.06	1.18	11	↗	1.30	1.35	4	→
3. Egypt	-0.57	-0.59	3	→	-0.33	-0.05	-84	↘	1.00	1.04	4	→	1.52	1.45	-5	↘	1.20	1.09	-9	↘	1.53	1.24	-19	↘
4. Kenya	-0.06	-0.11	76	↗	-0.16	-0.09	-44	↘	1.05	1.48	42	↗	1.22	2.27	86	↗	1.12	1.26	13	↗	1.00	1.39	39	↗
5. Zimbabwe	-0.05	-0.18	252	↗	-0.18	-0.06	-66	↘	0.71	0.91	28	↗	0.75	2.21	197	↗	0.21	0.03	-84	↘	0.31	0.49	55	↗
Panel C: Relative change in the poorest/richest household social gaps between the two time periods (6)																								
1. Burkina Faso	-0.44	-0.44	0	→	-0.31	-0.29	-6	↘	0.83	0.29	-66	↘	0.59	0.26	-56	↘	0.09	0.71	691	↗	0.10	0.63	553	↗
2. Cameroon	-0.42	-0.37	-10	↘	-0.58	-0.46	-19	↘	1.34	0.63	-53	↘	1.36	1.34	-2	→	0.73	1.36	86	↗	1.22	1.35	10	↗
3. Egypt	-0.59	-0.57	-3	→	-0.29	-0.04	-86	↘	1.12	0.33	-71	↘	1.57	0.67	-57	↘	0.96	0.57	-41	↘	1.60	0.80	-50	↘
4. Kenya	-0.05	-0.08	51	↗	-0.17	-0.15	-11	↘	0.69	1.38	99	↗	1.17	2.16	84	↗	0.96	1.05	10	↗	0.92	1.22	33	↗
5. Zimbabwe	-0.04	-0.18	328	↗	-0.14	-0.05	-62	↘	1.30	0.50	-62	↘	1.39	1.82	31	↗	0.14	0.66	364	↗	0.13	0.46	254	↗
Panel D: Relative change in the poorest/richest community endowment gaps between the two time periods (7)																								
1. Burkina Faso	-0.64	-0.39	-38	↘	-0.37	-0.34	-8	↘	1.22	0.71	-41	↘	0.90	0.72	-20	↘	0.68	0.77	14	↗	0.80	0.86	9	↗
2. Cameroon	-0.34	-0.21	-39	↘	-0.60	-0.50	-16	↘	1.62	0.79	-51	↘	1.53	1.33	-13	↘	0.72	0.52	-27	↘	0.78	0.48	-38	↘
3. Egypt	-0.44	-0.50	15	↗	-0.31	-0.04	-87	↘	0.81	1.55	92	↗	1.20	0.93	-23	↘	0.97	0.43	-55	↘	1.36	0.60	-56	↘
4. Kenya	-0.03	-0.08	209	↗	-0.13	-0.16	23	↗	0.67	0.81	21	↗	0.92	1.66	80	↗	0.80	1.12	40	↗	0.55	0.67	21	↗
5. Zimbabwe	-0.02	-0.17	650	↗	-0.14	0.00	-97	↘	1.27	0.50	-60	↘	0.70	2.00	187	↗	0.18	-0.15	-181	↘	0.20	-0.08	-138	↘

(1): 100*(Overall rate in DHS2 - Overall rate in DHS1)/Overall rate in DHS1. Values of change comprised between -5% and +5% are assumed to be insignificant;

(2): (Rate in the poorest group - Rate in the richest group)/Rate in the richest group;

(3): Infant mortality rate; (4): Under five years mortality rate;

(5): Estimated from Table V; (6): Estimated from Table VI; (7): Estimated from Table VII.

In Table VIII, we summarize the plurality of patterns of relative changes in the outcomes studied in relation to changes in socioeconomic inequalities over time. A decrease or stagnation in antennal attendance and full immunization leads to increases in poor health outcomes measured by stunting, underweight, infant mortality and under-five mortality. The general health and survival chances of children especially in Burkina Faso, Kenya and Zimbabwe tend to be deteriorating over time between the two surveys. While a case can be made about a link between the high prevalence of mother-to-child transmission of HIV on increased infant and child mortality in Kenya and Zimbabwe (Adetunji, 2000), it is unlikely to be the case in Burkina Faso where increasing resistance of malaria to drug treatment like in many sub-Saharan African countries (Rutstein, 2000), enduring poverty and limited economic opportunities may be playing an important role in perpetuating poor health status, given the low prevalence of HIV in this country. Additionally, Zimbabwe seems to experience a widening gap between richest and the poorest between the two surveys, and such gap tend to create barriers to access and use of health services by the poor segments of the population and to deteriorate their health status. These diverging patterns of the effects of socioeconomic inequalities on changes in health outcomes suggest nonlinear relationships in part because of the presence of other influential factors affecting both the magnitude and direction of these inequalities and health outcomes over time and space. These emerging patterns raise important issues for the influences of changes in SES inequalities on variations in health outcomes that deserve further investigation.

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Appendix I. Statistical procedures for constructing the indexes utilised in analyses

Formally, in PCA the optimal weights of the linear combination are mathematically computed to maximize its variance or equivalently the sum of squares of its correlations with the original variables. These principal components are ordered with respect to their variances so that the first few account for most of the variance. If we denote $x_1, x_2 \ldots x_p$ the original correlated variables and $X = (x_1, x_2 \ldots x_p)$ the (n, p) associated matrix, the PCA technique provides p uncorrelated principal components $u_1, u_2 \ldots u_p$ each of which is expressed as linear combination of the x_s and having maximal variance (we suppose that the xs have mean zero) that is:

$$u_j = \sum_{k=1}^{p} b_{jk} x_k = X b_j \qquad (1)$$

For the first component, the weight-vector b_1 is mathematically determined to maximize its variance or equivalently to maximize the sum of its squared correlations with the original variables. Where

$$\text{var}(u_1) = u_1' u_1 = b_1' X' X b_1 = b_1' \Omega b_1 \qquad (2)$$

With Ω being the covariance matrix of the x_s, var(.) denoting variance and ′ denoting transpose. The most convenient normalisation constraint being that b_1 is of unit length $\left(\sum_{k=1}^{p} b_{1k}^2 = 1 \right)$, the optimal weight-vector is a latent vector of the covariance matrix Ω and the corresponding maximum value of var(u_1) is the corresponding latent root, so that the first principal component is related to the highest latent root denoted λ_1. Similarly, the second component involves determining a second weight-vector b_2 such as to maximize var(u_2) subject to the constraints that $\sum_{k=1}^{p} b_{2k}^2 = 1$ and u_2 is uncorrelated to u_1. As above, the optimal weight-vector is the latent vector corresponding to the second highest latent root of the covariance matrix denoted λ_2, and so on for the other principal components.

From (1) we derive the matrix equation $U = XB$ where $U = (u_1, u_2 \ldots u_p)$ and B is the orthogonal matrix of latent vectors satisfying the property $B^{-1} = B'$. It follows that $\Omega = BD_\lambda B'$ where D_λ is the diagonal matrix of latent values; that is $Tr(\Omega) = Tr(D_\lambda)$ or $var(x_1) + var(x_2) + \ldots var(x_p) = \lambda_1 + \lambda_2 + \ldots \lambda_p$.

Thus, $\lambda_k / (\lambda_1 + \lambda_2 + \ldots \lambda_p)$ represents the proportion of the total variance explained by the k^{th} principal component.

Ultimately, the PCA aims to explain the variation expressed in the covariance matrix in terms of weighting vectors and variances of the principal components. However, it is easier to interpret the principal components when the latent vectors are transformed to correlations with the original variables. This is achieved by multiplying each latent vector b_k by the standard deviation of u_k denoted $\sqrt{\lambda_k}$. Furthermore, in many cases the units in which the variables are measured influence the variances and even if one uses the same unit, the variances may differ considerably. Thus, it is preferable to use correlation matrix rather than covariance matrix. Moreover, one may eventually standardize the principal components to variance unity.

Notes

[1] Telephone appears only in DHS-2; information on oven was available only for Cameroon (1991), and information was collected on stove only in Cameroon (1991, 1998) and Egypt (1992).

[2] Community surveys were carried out only for DHS-1 in four of the five countries (Egypt carried out no community survey).

[3] For Macro International Inc., DHS I surveys refer to those carried during the 1980s, DHS II to those fielded between 1990 and 1993, and DHS III to those carried out since 1994.

[4] While grouping clusters to define communities, we hypothesize that the numbering of clusters does reflect their proximity.

[5] Under the assumption that clusters numbering reflect their proximity.

[6] These labels are used for expository purposes, and not following a definition of poor and rich.

[7] In contrast, Filmer and Pritchett (1998) use Lowest 40%, Middle 40% and Top 20%.

[8] Poor/rich ratio is the ratio between the rate prevailing in the poorest population quintile and that found in the richest quintile (Gwatkin et al., 2000).

[9] Although there is considerable debate about the meaning and measurement of health inequalities, there is a consensus on the appropriateness of the concentration index, similar to the Gini coefficient frequently used in the estimation of income inequality. With values varying from -1 to +1, it measures the extent to which a health outcome is unequally distributed across groups. The closer the index to zero, the less unequally is health outcome distributed and conversely, the further away is the index from zero, the greater is the inequality (Gwatkin et al., 2000; Kakwani et al., 1997; Wagstaff et al., 1991).

Chapitre 2

Household and community socioeconomic influences on early childhood malnutrition in Africa

Household and Community Socioeconomic Influences on Early Childhood Malnutrition in Africa

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Abstract

This paper uses multilevel modelling and Demographic and Health Surveys (DHS) data from five African countries to investigate the relative contributions of compositional and contextual effects of socioeconomic status (SES) and place of residence in perpetuating differences in the prevalence of malnutrition among children in Africa. It finds that community clustering of childhood malnutrition is accounted for by contextual effects over and above likely compositional effects, that urban-rural differentials are mainly explained by the SES of communities and households, that childhood malnutrition occurs more frequently among children from poorer households and/or poorer communities and that living in deprived communities has an independent effect in some instances. This study also reveals that socioeconomic inequalities in childhood malnutrition are more pronounced in urban centres than in rural areas.

Key words: Socioeconomic Status, Malnutrition, Stunting, Multilevel Models, Africa

1. Introduction

Nutritional deficiencies and poor health of children are major public health concerns in developing countries, where they represent both a cause and a manifestation of poverty (ACC/SCN, 1997; World Bank, 2003). The evidence of short and long term consequences of childhood malnutrition is well documented and include increased susceptibility to infection and risk of mortality, poor functional outcomes such as impaired cognitive or delayed mental development and subsequently poor school performance and reduced intellectual achievement, poor productivity and work efficiency in adulthood (De Onis et al., 2000; Wagstaff & Watanabe, 2000). Ultimately malnutrition hinders human capital which is one of the most fundamental assets of households, communities and nations. As a result, impoverished disempowered women who were malnourished as infants are more likely to grow up within similar environments throughout their lifecycle and subsequently give birth to malnourished infants, thereby perpetuating the inter-generational effects of malnourishment and the cyclical nature of poverty (ACC/SCN, 1997; World Bank, 2002; 2003; Haddad et al., 2002).

Poverty also affects child malnutrition which is often the result of a long sequence of interlinked events ascribed to a wide range of biological, social, cultural and economic factors (Scrimshaw and SanGiovanni, 1997; Gopalan, 2000). In developing countries, such events are usually part of the so-called poverty syndrome with its synergistic attributes of low family income, large family size, poor education, poor environment and housing, poor access to or inequitable distribution within the country of safe water and health care services, and inadequate access to (and availability of) food or inequitable distribution of food available within the country (FAO, 1997; Peña & Bacallao, 2002). Poverty is however more than the lack of income or assets, since factors some of which are captured by the concept of

"capability" also influence child's nutritional status. This dimension of what has been defined as human poverty encompasses the household's opportunities within society (Haddad et al., 2003; ACC/SCN, 1997). Overall, prominent among factors influencing child nutritional status are the socioeconomic ones (Oakes and Rossi, 2003). Indeed a large body of health research in developing countries has incorporated a measure of socioeconomic status (SES) (Liberatos et al., 1998), and documented an inverse relationship between SES and a variety of health outcomes over time and space, regardless of the measure of the SES. Existing evidence lends support to the view that people privileged by more education, income, the dominant ethnicity, higher status jobs, and housing standards, have better health than their counterparts (Rajaram, et al., 2003; Kuate-Defo, 2001; Ruel et al., 1999; Adair & Guilkey, 1997; Ricci & Becker, 1996; Ruel et al., 1992; Cebu Study Team, 1991).

Yet little is known about inequalities in childhood malnutrition between socioeconomic groups in developing countries and especially in Africa (Alvarez-Dardet, 2000; Kuate-Defo, 2001). It is therefore important to investigate the extent to which such inequalities have varied over time and to address the issue of urban-rural differentials in those inequalities. Besides maternal education, the type of place of residence (rural versus urban) is one of the socioeconomic covariates most frequently used in studies of child nutrition and survival in the developing world (Ruel et al., 1992; Ricci & Becker, 1996; Madise et al., 1999; Tharakan and Suchindran, 1999). Assessing the socioeconomic influences on child's nutritional status both between and within developing countries has special appeal for policy and programs targeted at improving the well-being and survival chances of children. Unfortunately, the literature on these topics has been growing asymmetrically, the body of knowledge being built mainly on evidence from industrialized countries (Alvarez-Dardet, 2000). This gap is most glaring in the case of comparative and nationally representative studies of child malnutrition. More importantly, in the absence of standard measures of the SES of families and communities, researchers have typically used their own indicators, making cross-study comparisons

difficult. Furthermore, these indicators may measure slightly different dimensions of SES, leading to different classifications of poverty and subsequently to the identification and selection of different population groups (Glewwe & van der Gaag, 1990). Additionally, the modelling strategies of these works often ignore the multilevel nature of influences on child nutritional status and the hierarchical structure of the data used.

It is against this background that this study is designed in an attempt to investigate how the contexts and socioeconomic conditions of families and communities of residence influence the nutritional status of children over time and space. Specifically, the objectives of this paper are to: (i) Assess the extent of clustering of childhood malnutrition among communities and what factors account for it; (ii) Examine levels and trends in urban-rural differentials in childhood malnutrition, and whether they are influenced by the SES of communities and households; and (iii) Investigate the magnitude and changes over time in the influences of the SES of families and communities on child's nutritional status and the extent to which they interact with urban-rural residence to produce substantively different expressions of inequalities in the prevalence of childhood malnutrition.

2. Conceptual framework

UNICEF's (1990) and Mosley and Chen's (1984) frameworks both constitute a milestone in the sphere of research on determinants of child health in developing countries (Robert, 1999; Cebu Study Team, 1991) and are used in this study to articulate the relationships between household (the term household is used interchangeably with family in this paper) and community socioeconomic factors and child malnutrition in Africa. It is posited that socioeconomic factors operate at different levels (e.g., community, household, family) through more proximate determinants that in turn influence the risks and the outcomes of malnutrition.

According to these frameworks, child's welfare (morbid status, nutritional status, immunity status, and survival status) is largely determined by five groups of proximate risk and protective factors: (i) child's characteristics, prominent among which are biological variables such as age, sex, birth weight, gestational length, health conditions at birth, and birth order; (ii) mother's reproductive patterns and cultural practices, encompassing age at puberty, age at sexual debut, age at maternity, birth spacing practices, religious affiliation and religiosity, and exposure to media; (iii) mother's nutritional behaviour and status proxied by breastfeeding patterns and body mass index; (iv) access to and utilisation of health care services, especially for antenatal care, delivery and immunization of children; and (v) household size and composition that may be measured by both the total number of its members and especially those under five years of age as well as the gender composition of the household. There is an extensive literature documenting the potential effects of these factors on child's health (Kuate-Defo, 2001; Ruel et al., 1999; Adair & Guilkey, 1997; Ricci & Becker, 1996).

Socioeconomic family-level variables encompass parents' education and employment, household's income and ownership of consumer durable goods, water, sanitation and housing. Parental education usually correlates strongly with parental occupation and often serves as a proxy for household's assets and marketable commodities the household consumes. Mother's education and occupation can affect child's health by influencing her choices, increasing her skills and improving behaviours related to preventive care, nutrition, hygiene, breastfeeding, parity and birth intervals (Mosley & Chen, 1984). Typically, inadequate or improper education of women often exacerbates their inability to generate resources for improved nutrition for their families (UNICEF, 1990). A number of studies have supported that mother's schooling is a stronger determinant of child welfare, but have also shown some inconsistencies about the magnitude and significance of its effects compared to those of other socioeconomic indicators such as income or wealth (Ruel et al., 1992; Cleland & van Ginneken, 1988).

The household socioeconomic factors mainly influence its member's health through the income and wealth effects. In the absence of reliable information on income, many indicators may capture the household's financial ability to secure goods and services that promote better health, help to maintain a more hygienic environment, and ensure adequate nutrition needs. For example, inaccessibility to clean water and poor environmental sanitation increase the prevalence of both malnutrition and disease. Inadequate access to water may also affect nutrition indirectly by increasing the work-load on mothers and thus reducing the time available for child care (Kuate-Defo, 2001; UNICEF, 1990; Mosley & Chen, 1984).

Community-level covariates include availability of health-related services and relevant socioeconomic infrastructures. Community socioeconomic factors may influence child health and nutrition through two major pathways: by shaping the family/household-level SES, and/or by directly affecting the social, economic and physical environments shared by residents, which in turn operate through more proximate attributes to impact health outcomes (Robert, 1999). Public services such as electricity, water, sewerage, transportation and telephone networks are likely to be quite inadequate in lower socioeconomic communities with often deleterious consequences on child's health. Similarly, the existence and quality of, and access to, health-related and socioeconomic services usually differ by socioeconomic characteristics of communities. Even where these basic services and foods are available in deprived areas, their access may be hampered by barriers such as inadequate or unsafe transportation systems (Mosley & Chen, 1984).

Despite the overwhelming interest and progress on SES in health research, its conceptualization or measurement remain unsettled (Lynch and Kaplan, 2000; Alder et al., 1993; Campbell and Parker, 1983). Moreover, there is still no consensus on its nominal definition or on a widely accepted measurement tool (Oakes and Rossi, 2003; Cortinovis et

al., 1993; Campbell and Parker, 1983). In this context, researchers working on developing countries often use their own individual-, household- or community-level socioeconomic indicators, thus making cross-national comparisons virtually impossible. Moreover, since different SES indicators may be correlated with one another, their use in the same statistical model is usually called into question with arguments invoking problems of multicollinearity, instability of estimated parameters and their interpretation (Alder et al., 1993; Campbell and Parker, 1983). The ignorance of father's education is also a shortcoming of current approaches since in many settings of the developing world, the husband generally takes decision regarding fertility, contraception and use of health care services, so that certain behaviours and practices which may affect child health and nutrition depend on the father and specifically on his level of education (Kuate-Defo and Diallo, 2002). Moreover from experience, the distribution of the paternal education is heterogeneous than maternal education particularly within rural areas, thus increasing the likelihood of a statistically significant relationship with child nutritional status. Cortinovis et al. (1993) have also stressed the need to construct overall socioeconomic indexes rather than using individual indicators.

3. Materials and methods

This study uses data from Demographic and Health Surveys (DHS) in the following five African countries which carried out more than one DHS in the 90s: Burkina Faso (1992/93, 1998/99); Cameroon (1991, 1998); Egypt (1992, 2000); Kenya (1993, 1998) and Zimbabwe (1994, 1999). The DHS have comparable information on community and household characteristics as well as on nutrition and health of women aged 15-49 years and their children born within three to five years before the survey date, known to be of good quality. We restrict the samples to children aged 3-36 months to ensure strict comparability of the data-sets used in the analyses. We also exclude children whose mother is not resident of the household surveyed. Table 1 displays the sample sizes as well as the hierarchical distribution of the number of unites at different level (child, mother, household, community).

The selected countries exhibit quite different socioeconomic and demographic profiles. Burkina Faso is one of the least developed countries, while Egypt by contrast is one of the most affluent. Real Gross Domestic Product (GDP) per capita vary from almost $US 250 in Burkina Faso to $US 1 230 in Egypt, with intermediate values close to $US 330 in Kenya, $US 625 in Zimbabwe and $US 665 in Cameroon (World Bank, 2002). According to the Human Development Index (HDI), Egypt is ranked at the position 7 (out of a total of 48 African countries); Zimbabwe, Kenya and Cameroon are in the middle class, ranking 14th, 17th and 18th, respectively; and Burkina Faso lags behind at the 45th position, just before Mozambique, Burundi, Niger and Sierra Leone (UNDP, 2002). The selection of Burkina Faso furthermore introduces a dimension of extreme poverty and poor infrastructural development that characterizes a number of Sub-Saharan African countries. Hence, although the selected countries are not representative of the entire African continent, their geographic location (West, Central, North, East and Southern Africa) and socioeconomic and cultural diversities constitute a good yardstick for the continent.

Focusing on the relationship between nutritional status and SES within Africa is of special importance. In effect, the African continent is not on target to reach the first Millennium Development Goal of eradicating extreme poverty and hunger by the year 2015. Despite the success of the World Summit for Children (1990), the International Conference on Nutrition (1992), and the World Food Summit (1996) in achieving their primary goal (i.e. to arouse interest and commitment in policies, programs and activities aimed at improving the nutritional status of populations), actual progress in nutritional well-being continue to bypass many African countries and population subgroups. Indeed, malnutrition rates among preschool children are on the rise in some countries, whilst in many others, they remain disturbingly high or are declining only sluggishly, with very low prospects of significant improvement. Between 1990 and 2000, the overall prevalence of stunting among preschool

children in Africa has diminished by only 2.5 percentage points (from 37.8% to 35.2%), and the absolute number of malnourished children has risen by almost 13.5% (from 41.7 to 47.3 millions). Eastern Africa witnessed an increase of nearly 29% (from 17.1 to 22 millions) of undernourished children during this period (De Onis et al., 2000). The ever worsening political climate in most sub-Saharan African regions resulting in wars and refugee problems as well as the restricted inflow of foreign capital investments have titled the economies downwards with an unprecedented hardship on populations, especially on children as they are more prone to suffer from nutritional deficiencies than adults because their physiologically less stable situation (World Bank, 2003; Tharakan & Suchindran, 1999).

An important issue in studies dealing with area effects on health is the definition of "communities" or "neighbourhoods" or, more precisely the geographic area whose characteristics are thought to be relevant to the health outcome under study. Most health-based studies in developing countries using community-level characteristics rely on sampling cluster as proxy for community, and very few have provided a concise definition of community. Conceptually, the size and definition of community may vary according to the processes through which area effect is hypothesized to operate and to the health outcome studied. For example, areas based on administrative boundaries may be relevant when hypothesized processes involve public policy; whereas geographically defined neighbourhoods may be relevant when physical environment is supposed to be the most important (Diez-Roux, 2001). Nevertheless, researchers working with national representative samples often have no choice but to rely on administrative definitions for which standard data are available, even though these structures may have no explicit theoretical justification in terms of the outcome being studied (Duncan et al., 1998). This study defines community by grouping sampling clusters within administrative units in order to have desirable minimum number of communities and number of households per community in each urban and rural sample.

3.1. Dependent variable

Among various growth-monitoring indices, there are three commonly used comprehensive profiles of malnutrition in children namely stunting, wasting and underweight, measured by height-for-age, weight-for-height, and weight-for-age indexes respectively. Stunting, or growth retardation, or chronic protein-energy malnutrition results in young children from recurrent episodes or prolonged periods of nutrition deficiency for calories and/or protein available to the body tissues, inadequate intake of food over a long period of time, or persistent or recurrent ill-health. Wasting or acute PEM captures the failure to receive adequate nutrition during the period immediately before the survey, resulting from recent episodes of illness and diarrhea in particular, or from acute food shortage. Underweight status is a composite of the two preceding ones, and can be due to either chronic or acute PEM (Kuate-Defo, 2001). As recommended by the World Health Organization (WHO), children whose index is more than two standard deviations below the median NCHS/CDC/WHO reference population are classified as malnourished, that is stunted, wasted or underweight depending on the index used.

In this paper we use stunting as an indicator of child's nutritional status. From a pragmatic perspective, it is not relevant to focus on wasting since it is generally of very low prevalence. In our data-sets for example, the prevalence of wasting in four of the five countries and two periods ranges from 3% to 7.5% against a range of 20%-33% for stunting. This relatively low level of wasting limits the extent to which it can be used as an indicator of malnutrition, since much larger samples are required to explore the correlates of this outcome. Moreover, a number of studies have shown that wasting is volatile over seasons and periods of sickness (World Bank, 2002), and is often insensitive to prevailing socioeconomic conditions, exhibiting insignificant socioeconomic differentials, and unable to manifest the steep gradients related to SES as observed with stunting (Zere & McIntyre, 2003). Although underweight often parallels stunting, seasonal weight recovery and some children being

overweight can also affect weight-for-age index. In contrast, the height-for-age measure is less sensitive to temporary food shortages and thus, stunting is considered the most reliable indicator of child's nutritional status, especially for the purpose of differentiating socioeconomic conditions within and between countries (Zere & McIntyre, 2003).

3.2. Key independent variables

Four key independent variables are of interest in this study and are defined in Appendix 1. They are place of residence (urban or rural), household wealth index, household social status and community endowment status. Following recent works of Filmer & Pritchett (2001) and Gwatkin et al. (2000) and the conceptual framework presented above that recognizes the distinctive feature of socioeconomic indexes measured at the household versus community levels, three relevant and complementary socioeconomic indexes are constructed using principal component analysis: (i) Household wealth index that captures household's possessions, type of drinking water source, toilet facilities and flooring material, and thus expands or may be used as proxy for the commonly used income or expenditures variables; (ii) Household social index, that encompasses maternal and paternal education and occupation; and (iii) Community endowment index or simply community SES, defined from the proportion of households having access to electricity, telephone and cleaned water, together with relevant community-level information retrieved from community surveys when available. These community-level variables include accessibility of roads, availability of sewerage system, availability of or distance to health services, pharmacy and other socioeconomic infrastructures such as schools, markets, transportation services, banks, and postal services. In the descriptive analyses, the three indices are assigned to five 20% quintiles classified as poorest (bottom 20%), low (next 20%), middle (next 20%), high (next 20%) and richest (top 20%). In the multivariate analyses, these socioeconomic indexes are treated as continuous and centred variables.

In a previous study (Fotso and Kuate-Defo, in press), we showed that each of these socioeconomic indexes is internally coherent, in that it produces sharp separations across its quintile groups for each of the indicator used in its construction, indicating their high degree of summarizing information contained in the assets variables. The explanatory power of the indexes was then evaluated on various health outcomes including health care services utilization (antenatal care, immunization), malnutrition (stunting, underweight), and mortality (infant mortality, under-five mortality). The association generally exhibited remarkable socioeconomic gradients in each of the five selected countries and survey period.

3.3. Control variables

Control variables used include: (i) at the household level, the number of household members and the number of under-five children (both continuous centred variables), and their quadratic term; (ii) at the mother level, religion, exposure to media such as radio and television, current age, teenage childbearing, and nutritional status; and (iii) at the child level, current age, sex, low birth weight, antenatal care, place of delivery, age-specific immunization status, breast feeding duration, birth order and interval. Appendix 1 summarizes the description of variables used in this study.

3.4. Statistical methods

Descriptive analyses are used to portray the association between each socioeconomic index and childhood malnutrition by place of residence. To deepen the urban-rural differences in stunting by SES gradient, this paper calculates concentration index according to the following formulae due to Kakwani et al. (1997):

$$\begin{cases} C = \dfrac{2}{n\mu}\sum_{i=1}^{n} y_i R_i - 1 \\ Var(C) = \dfrac{1}{n}\left[\dfrac{1}{n}\sum_{i=1}^{n} a_i^2 - (1+C)^2\right] \\ a_i = \dfrac{y_i}{\mu}(2R_i - 1 - C) + 2 - q_{i-1} - q_i \end{cases} \quad (1)$$

Where C is the concentration index; n is the sample size; y_i refers to the outcome variable (stunting); R_i is the relative rank of the individual i; μ is the mean of y; q_i is the cumulative proportion of y $\left(q_i = \frac{1}{n}\sum_{k=1}^{i} y_k\right)$. The concentration curve plots the cumulative proportions of the population (beginning with the most disadvantaged) against the cumulative proportion of health outcome. The resulting concentration index which is similar to the Gini coefficient varies from -1 to +1, and measures the extent to which a health outcome is unequally distributed across groups. The closer is the index to zero, the less unequally distributed among socioeconomic groups is the health outcome. The sign of the index reflects the expected direction of the relationship between the SES and the health outcome (Gwatkin et al., 2000; Wagstaff et al., 1991).

For multivariate analyses, this study uses multilevel models to investigate the effects of context and to quantify the influences of SES on early childhood malnutrition, controlling for variables at different levels. In effect, in the social and biomedical sciences, cross-sectional data usually have a hierarchical structure due mainly to random sampling of naturally occurring groups in the population. As a result, observations from the same group are expected to be more alike at least in part because they share a common set of characteristics or have been exposed to a common set of conditions, thus violating the standard assumption of independence of observations inherent to conventional regression models. Consequently, unless some allowance for clustering is made, standard statistical methods for analyzing such data are no longer valid, as they generally produce downwardly biased variance estimates, leading for example to infer the existence of an effect when in fact that effect estimated from

the sample could be ascribed to chance (Rasbash et al., 2002). Furthermore, to gain a more complete understanding of the influences of SES on child malnutrition, the child, mother, household and community levels need to be considered simultaneously. This requirement however poses technical difficulties for traditional statistical modelling techniques as they operate only at a single level. By simultaneously modelling the effects of group- and individual-level predictors, with individuals as units of analysis, multilevel models also permit to disentangle contextual effects from compositional ones (Goldstein, 1999; Snijders & Bosker, 1999).

DHS data basically form a hierarchical structure with four levels: children nested within mothers at level 2; mothers clustered within households at level 3; and households in turn nested within communities at level 4. However, with an average of 1.1 children aged 3-36 months per mother, and almost 1.2 children per household in the data as can been seen in Table 1, a family level is defined by collapsing child-, mother- and household-level data. Two-level logistic regression analyses are then carried out in each country and period according to the following system of equations:

$$\begin{cases} Logit(\pi_{ij}) = \ln\left[\dfrac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_{0j} + \sum_{k=1}^{p}\beta_k x_{ij}^{(k)} + \sum_{l=1}^{q}\delta_l z_j^{(l)} \\ \beta_{0j} = \beta_0 + u_{0j} \end{cases} \qquad (2)$$

In this system of equations, i and j refer to the family and community respectively; π_{ij} is the probability that child referenced (i, j) is stunted; $x_{ij}^{(k)}$ and $z_j^{(l)}$ are the k^{th} family-level covariate and the l^{th} community-level covariate respectively; β_{0j} represents the intercept modelled to randomly vary among communities; the β_k and the δ_l represent the regression coefficients of the familial explanatory variables and the community explanatory variables respectively; and u_{0j} is the random community residuals distributed as $N(0, \sigma_u^2)$ (Rasbash et al., 2002; Goldstein, 1999; Snijders & Bosker, 1999). Models are fitted using the MLwiN software with

Binomial, Predictive Quasi Likelihood (PQL) and second-order linearization procedures (Rasbash et al., 2002; Goldstein, 1999). Since DHS surveys often over-sampled certain sub-groups in order to obtain statistically meaningful sample sizes for analysis, sampling probabilities are used in all the analyses to weight information at the individual level, so that the resulting findings are generalized to the total population. Finally, we assess changes over time by comparing the coefficients between the two survey periods. Calculation of the standard deviation of change is based on the assumption of independence of the DHS-1 and DHS-2 samples in each country. This may not be the case strictly-speaking, since some households may be selected in both samples.

4. Findings

Descriptive results are shown in Table 2 and Figures 1 to 3, whilst multivariate analyses are displayed in Tables 3 to 5. The main findings emerging from these results are presented focusing primarily on the first survey (DHS-1) and reference is made of DHS-2 when assessing change over time in the magnitude and significance of effects of covariates.

4.1. Descriptive analyses

Table 2 displays the prevalence of stunting in the five countries and at two points in time. Irrespective of the country and the survey date, chronic malnutrition is highly prevalent and affects between 23.5% (Zimbabwe, 1994) and 33% (Kenya, 1993) of children aged 3-36 months. Furthermore, the nutritional status of children has substantially deteriorated during the inter-survey period in Zimbabwe and Cameroon (by almost 25%), and to a lesser degree in Burkina Faso (by 9%), corresponding to an average annual increase of 4.5%, 3.2% and 1.4% respectively. In contrast, the nutritional status of children in Egypt continues to improve consistently over time nationwide, with a drop of malnutrition rate by almost 31% (or 4.5% on an annual basis). Between these two extremes, malnutrition rate has remained unchanged in Kenya. Urban-rural differentials in childhood malnutrition are also apparent. As expected

for all countries and over time, the prevalence of childhood malnutrition is higher in rural areas than in urban centres, with rural/urban ratios of 1.9 in Cameroon, 1.6 in Burkina Faso and almost 1.4 in the three other countries. This urban advantage is reduced over time especially in Cameroon due to a sharp increase in the prevalence of stunting among urban children (by almost 48%), as compared to an increase of nearly 10% among their rural counterparts.

In general the three socioeconomic indices indicate that the poorest segment of the population has the highest prevalence of malnutrition in all countries and over time whereas its richest counterpart has the lowest prevalence. Figures 1 to 3 illustrate this general pattern of prevalence of stunting among children by socioeconomic quintile groups. The prevalence of stunting generally declines steadily with increasing SES. To portray this pattern further, the poor/rich ratio is used in Table 2 for assessing the general order of magnitude of differences between the poorest and the richest groups of the population. Cameroon has the highest poor/rich ratio for the household wealth index, with children from the poorest SES group having almost 3.2 times greater chance to be stunted than their counterparts in the richest SES group, followed by Kenya (2.1), Egypt and Zimbabwe (1.8) and Burkina Faso (1.5). The poor/rich ratio for the household social index ranges from almost 1.6 in Burkina Faso to nearly 2.3 in Cameroon and Zimbabwe, through almost 1.9 in Egypt and Kenya. Finally, the bivariate association between community endowment index and child nutrition shows that children from communities in the poorest SES group are almost 3.0 times more likely in Cameroon, 2.1 times more likely in Zimbabwe to be stunted, than their counterparts in the most privileged communities.

Table 1. Hierarchical distribution of the number of units at each potential level of analysis

	Burkina Faso		Cameroon		Egypt		Kenya		Zimbabwe	
	1993	1999	1991	1998	1992	2000	1993	1998	1994	1999
Communities	76	75	76	76	74	84	83	85	70	70
Households	2 172	2 171	1 270	1 489	3 442	4 988	2 565	2 530	1 716	1 564
Mothers	2 582	2 611	1 445	1 669	3 673	5 258	2 674	2 622	1 812	1 637
Children[a] aged 3 to 35 months	2 688	2 730	1 619	1 816	4 134	5 873	3 013	2 907	1 927	1 714
Children per mother	1,0	1,0	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,0
Mothers per household	1,2	1,2	1,1	1,1	1,1	1,1	1,0	1,0	1,1	1,0
Children per household	1,2	1,3	1,3	1,2	1,2	1,2	1,2	1,1	1,1	1,1
Household per community	28,6	28,9	16,7	19,6	46,5	59,4	30,9	29,8	24,5	22,3
Children per community	35,4	36,4	21,3	23,9	55,9	69,9	36,3	34,2	27,5	24,5

[a]Children whose mother is not resident of the household surveyed are excluded from analyses.

Table 2. Prevalence[a] of stunting among children[b] aged 3-35 months by place of residence, and poor/rich ratios[c] according to household and community socioeconomic status

	Burkina Faso		Cameroon		Egypt		Kenya		Zimbabwe	
	1993	1999	1991	1998	1992	2000	1993	1998	1994	1999
1. Prevalence										
Overall	31,3	34,0	25,4	31,7	29,5	20,4	33,0	33,0	23,5	29,3
Urban	20,7	22,7	16,5	24,4	23,4	15,2	23,8	24,4	18,6	24,2
Rural	33,1	35,5	31,2	34,5	33,0	23,6	34,1	34,8	25,1	31,6
Rural/urban ratio	1,6	1,6	1,9	1,4	1,4	1,6	1,4	1,4	1,4	1,3
2. Poor/rich ratio										
Household wealth index	1,5	1,5	3,2	2,3	1,8	2,0	2,1	2,5	1,8	2,2
Household social index	1,6	1,2	2,4	1,7	1,8	1,1	1,9	2,4	2,2	1,5
Community endowment index	1,9	1,6	3,0	1,7	1,7	2,4	1,5	1,8	2,1	1,4

[a]Weighted by sampling probabilites.

[b]Children whose mother is not resident of the household surveyed are excluded from analyses.

[c]Ratio between the rate of malnutrition prevailing in the poorest 20% population quintile and that found in the richest 20% quintile.

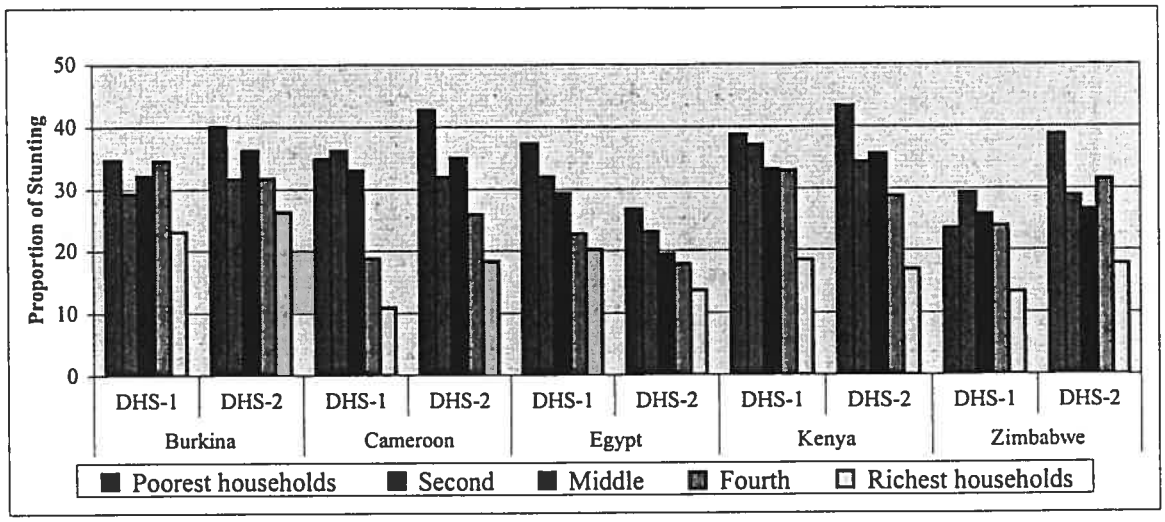

Figure 1. Household wealth status and early childhood malnutrition

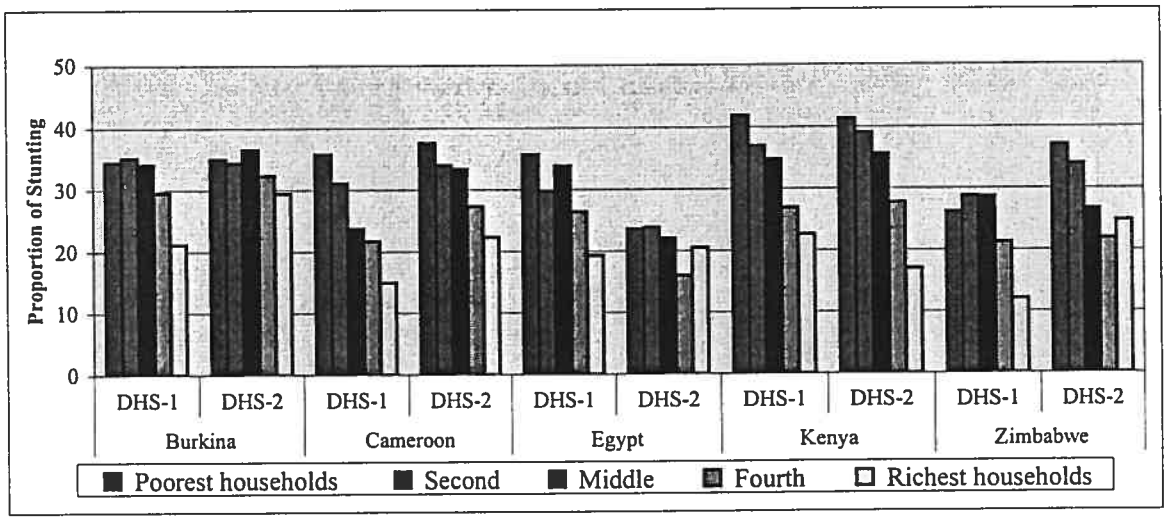

Figure 2. Household social status and early childhood malnutrition

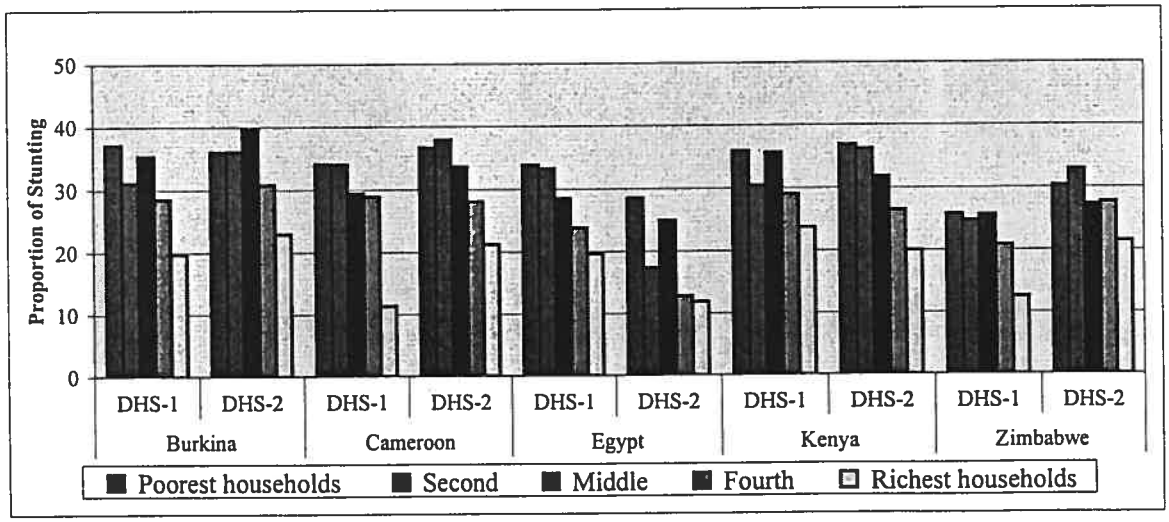

Figure 3. Community socioeconomic status and early childhood malnutrition

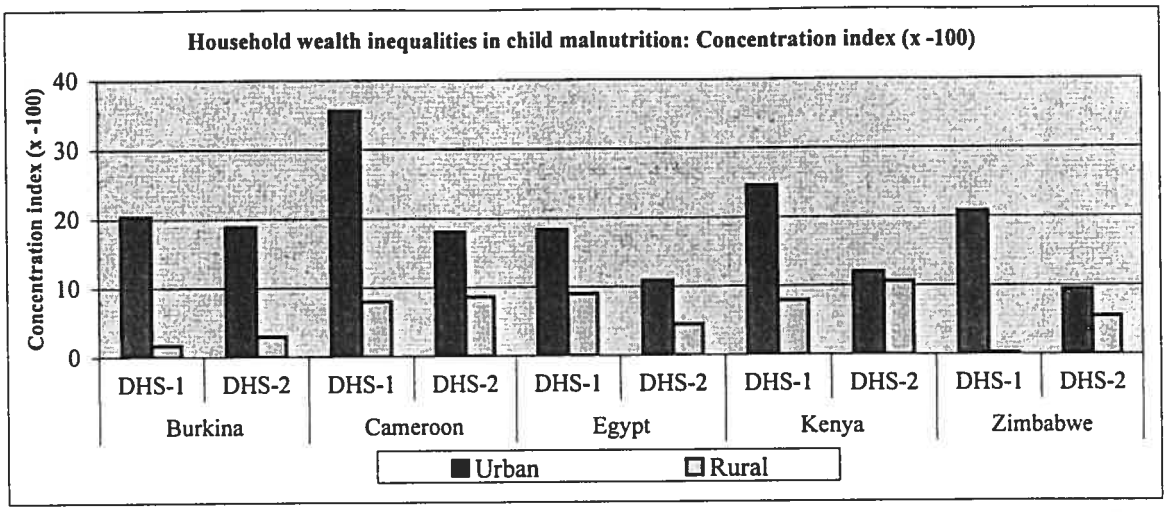

Figure 4. Household wealth inequalities in child malnutrition by place of residence: Concentration index[a]

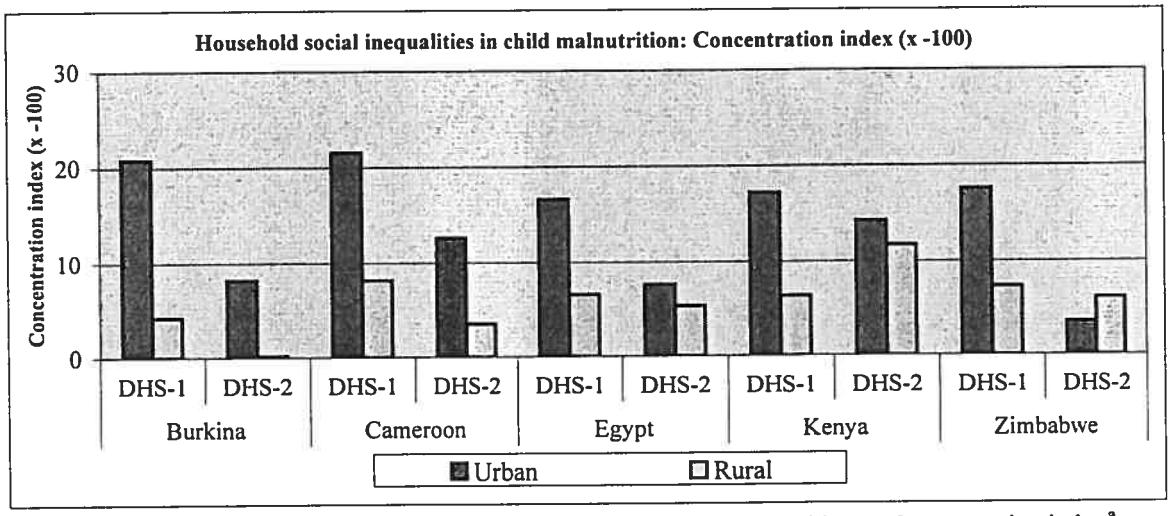

Figure 5. Household social inequalities in child malnutrition by place of residence: Concentration index[a]

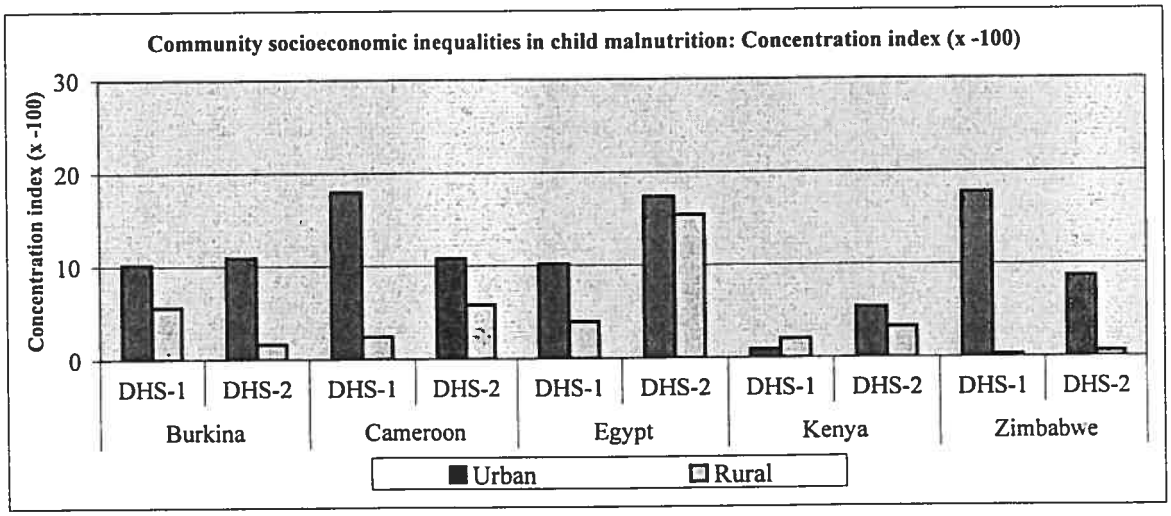

Figure 6. Community socioeconomic inequalities in child malnutrition by place of residence: Concentration ind

[a]Concentration index for ill-health varying typically between 0 and -1, it has been multiplied by -100 in order to yield values between 0 and 100.

Whether socioeconomic inequalities vary significantly by place of residence is further assessed. Figures 4 to 6 display the magnitude of inequalities in urban versus rural areas using concentration index. The estimates are higher in urban centres than in rural areas, regardless of the country, the measure of SES and the survey date. The only exceptions are noted in Zimbabwe (1999) for household social index and in Kenya (1993) for community SES. In the former case, the urban coefficient is not statistically significant at the level of 0.10 whilst in the latter both urban and rural coefficients fail to reach statistical significance.

4.2. Variability in child stunting among communities

Panel A of Table 3 displays estimates of the variability in malnutrition among children across families and communities, with and without accounting for measured covariates. Community-level random variations are significantly different from zero in all countries and survey periods ($p< 0.01$), suggesting apparent variability among communities in early childhood stunting (Model a). The intra-community correlation (ICC), which measures the proportion of the total variance which is between communities (Pebley et al., 1996; Snijders & Bosker, 1999), is more than 17% in Cameroon, and almost or less than 5% in the four other countries. The ICC Comparing Model b to Model a indicates that compositional effects explain a large amount of the variation in Cameroon (39%), in Egypt (28%) and in Zimbabwe (20%). In Burkina Faso and Kenya compositional effects explain less than 4% of the variation among communities. A significant variation between communities remains in all countries ($p<0.05$ in Zimbabwe, $p<0.01$ in the two other countries). It is therefore clear that differences among communities with regard to childhood malnutrition cannot be explained simply by familial socioeconomic and demographic factors.

Whether this variability is explained by community characteristics such as urban-rural residence and community SES is examined in Model c. Variability in child stunting among communities further decreases in Zimbabwe and Burkina Faso, indicating that the place of residence and the SES of the community account for almost 7% of the contextual effects in

childhood malnutrition. In the three other countries, including community covariates slightly increased the contextual effects by 3% to 7%.

4.3. Urban-rural differentials in childhood malnutrition

The second objective of this study is to evaluate urban-rural differentials in childhood malnutrition and the extent to which they are explained by the SES of communities and families. Converting estimates in Panel B of Table 3 into odds ratios indicates that malnutrition rates in rural areas are almost 2.6 times higher in Cameroon, nearly 90% higher in Burkina Faso and close to 60% higher in Egypt and Kenya, and Zimbabwe, than in cities (Model a). Controlling for community endowment index (Model d) shows that the SES of communities explains between 32% and 39% of urban-rural differentials in Kenya, Burkina Faso and Egypt, and more than 50% in Cameroon and Zimbabwe, with a loss of statistical significance at the level of 0.10 in all countries except in Burkina Faso. Similar effects are noted for the household wealth index (Model b) and the Household social index (Model c). Model e reveals that both household wealth and household social statuses explain much urban-rural differentials, as urban malnutrition rates are now indistinguishable from rural ones at the level of 0.10 in all countries and periods except in Egypt (2000). Controlling for the three socioeconomic indexes (Model f) further reduces estimates to loss of statistical significance in all countries and periods, indicating that urban-rural differentials in child malnutrition are mainly accounted for by household and community SES. However, it is possible that some proportion of the rural-urban differentials could be attributed to selective migration rather than simply to an outcome effect of household or community SES. In Kenya and Zimbabwe, estimates are turned negative (though not statistically significant at the level of 10%), indicating that children from rural areas may tend to have better nutritional status than their counterparts in urban centres when SES is adjusted for. Finally, adjusting for the household, mother and child covariates changes only marginally the magnitude of the difference between urban and rural likelihood of malnutrition in the selected countries.

Table 3. Estimates (coefficients) of the variation among communities and families, and the urban-rural differentials in childhood malnutritio

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	1993	1999	Change	1991	1998	Change	1992	2000	Change	1993	1998	Change	1994	1999	Change
Panel A: Variation (coefficients) among communities and families in childhood malnutrition															
Model a: Without covariates.															
σ^2_{u0}	0,111 ***	0,125 ***		0,687 ***	0,291 ***		0,176 ***	0,457 ***		0,157 ***	0,184 ***		0,169 ***	0,225 ***	
ICC[a]	3,3%	3,7%		17,3%	8,1%		5,1%	12,2%		4,6%	5,3%		4,9%	6,4%	
Model b: Controls for household wealth index, household social index, and other household, mother and child covariates[1].															
σ^2_{u0}	0,107 **	0,126 ***		0,422 ***	0,233 ***		0,126 ***	0,379 ***		0,152 ***	0,102 **		0,135 **	0,189 ***	
ICC	3,1%	3,7%		11,4%	6,6%		3,7%	10,3%		4,4%	3,0%		3,9%	5,4%	
Model c: Expands Model b by adding urban-rural residence and community endowment index.															
σ^2_{u0}	0,100 **	0,124 ***		0,436 ***	0,242 ***		0,135 ***	0,368 ***		0,158 ***	0,117 **		0,124 **	0,182 ***	
ICC	2,9%	3,6%		11,7%	6,9%		3,9%	10,1%		4,6%	3,4%		3,6%	5,2%	
Panel B: Urban-rural differentials (coefficients) in childhood malnutrition															
Model a: Without covariates.															
Rural residence	0,642 ***	0,659 ***	0,02	0,963 ***	0,579 ***	-0,38	0,502 ***	0,537 ***	0,04	0,466 **	0,419 ***	-0,05	0,456 **	0,376 *	-0,08
Model b: Controls for household wealth index.															
Rural residence	0,350 ***	0,227	-0,12	0,213	0,023	-0,19	0,263 **	0,420 **	0,16	-0,150	-0,210	-0,06	-0,218	-0,170	0,05
Model c: Controls for household social index.															
Rural residence	0,318 *	0,703 ***	0,39	0,699 ***	0,435 **	-0,26	0,316 ***	0,462 ***	0,15	0,111	0,139	0,03	0,178	0,101	-0,08
Model d: Controls for community endowment index.															
Rural residence	0,418 ***	0,656	0,24	0,438	0,027	-0,41	0,306	0,278	-0,03	0,318	0,001	-0,32	0,226	-0,001	-0,23
Model e: Controls for both household wealth and social indexes.															
Rural residence	0,173	0,312	0,14	0,189	0,032	-0,16	0,206	0,396 **	0,19	-0,280	-0,255	0,03	-0,311	-0,315	0,00
Model f: Controls for community endowment index and household wealth and social indexes.															
Rural residence	0,033	0,656	0,62	0,009	-0,050	-0,06	0,157	0,224	0,07	-0,221	-0,105	0,12	-0,294	-0,379	-0,09
Model g: Expands Model f by adding the other household, mother and child covariates (3).															
Rural residence	0,031	0,879	0,85	-0,140	0,120	0,26	0,003	0,152	0,15	-0,088	-0,164	-0,08	-0,431	-0,362	0,07

*p < 0.10; **p < 0.05; ***p < 0.01; [a]Intra-community correlation.

σ^2_{u0} is the estimated coefficient for community-level random variation: statistical testing is about the hypothesis $\sigma^2_{u0} = 0$.

[1]The other covariates include (i) at the household level: the number of members and the number of under-five children, and their quadratic term; (ii) at the mother level: religion, exposure to media, current age, teenage first childbearing, and nutritional status; and (iii) at the child level: current age, sex, low birth weight, antenatal care, place of delivery, age-specific immunization status, breast-feeding duration, and birth order/interval.

Table 4. Estimates (coefficients) of the gross socioeconomic effects on childhood malnutrition

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	1993	1999	Change	1991	1998	Change	1992	2000	Change	1993	1998	Change	1994	1999	Change
Model a: Estimated effects (coefficients) of the household wealth index															
(1) HH wealth[a]	-0,308 ***	-0,313 ***	-0,01	-0,649 ***	-0,431 ***	0,22 **	-0,257 ***	-0,160 ***	0,10	-0,403 ***	-0,540 ***	-0,14	-0,345 ***	-0,319 ***	0,03
(2) HH wealth	-0,223 ***	-0,261 ***	-0,04	-0,603 ***	-0,427 ***	0,18	-0,222 ***	-0,144 ***	0,08	-0,430 ***	-0,587 ***	-0,16	-0,411 ***	-0,373 ***	0,04
(3) HH wealth	-0,374 ***	-0,230 ***		-0,631 ***	-0,410 ***		-0,227 ***	-0,184 *		-0,432 ***	-0,332 **		-0,836 ***	-0,197	
(3) HH wealth-Rural[b]	0,339 **	-0,109		0,075	-0,030		0,007	0,050		0,002	-0,546 ***		0,691 ***	-0,302	
Model b: Estimated effects (coefficients) of the househod social index															
(1) HH social[c]	-0,299 ***	-0,083 *	0,22 **	-0,342 ***	-0,197 ***	0,15	-0,237 ***	-0,123 ***	0,11 *	-0,315 ***	-0,379 ***	-0,06	-0,255 ***	-0,243 ***	0,01
(2) HH social	-0,232 **	0,026	0,26 **	-0,257 ***	-0,135 **	0,12	-0,206 ***	-0,108 **	0,10	-0,307 ***	-0,369 ***	-0,06	-0,228 ***	-0,226 ***	0,00
(3) HH social	-0,522 ***	-0,201		-0,436 ***	-0,219 *		-0,249 **	-0,123		-0,398 **	-0,433 ***		-0,406 *	-0,206	
(3) HH social-Rural[d]	0,395 ***	0,273 **		0,262	0,103		0,062	0,020		0,099	0,074		0,215	-0,024	
Model c: Estimated effects (coefficients) of the community endowment index															
(1) Com SES[e]	-0,241 ***	-0,256 ***	-0,02	-0,461 ***	-0,291 ***	0,17	-0,232 ***	-0,235 **	0,00	-0,203 **	-0,259 ***	-0,06	-0,224 **	-0,214 **	0,01
(2) Com SES	-0,135 *	-0,002	0,13	-0,311 **	-0,281 **	0,03	-0,122	-0,161	-0,04	-0,085	-0,259	-0,17	-0,127	-0,216	-0,09
(3) Com SES	-0,675 ***	-0,023		-1,624 ***	-0,244 **		-0,934 ***	-1,096 ***		-0,045	-0,085		-1,565 **	-0,687	
(3) Com SES-Rural[f]	0,552 **	0,387		1,453 ***	-0,093		0,857 ***	0,985 ***		-0,046	-0,558		1,539 **	0,782	
Model d: Estimated effects (coefficients) of the household wealth and social indexes															
(1) HH wealth	-0,188 **	-0,339 ***	-0,15	-0,610 ***	-0,439 ***	0,17	-0,177 ***	-0,133 ***	0,04	-0,272 ***	-0,374 ***	-0,10	-0,257 ***	-0,230 **	0,03
(1) HH social	-0,212 **	0,046	0,26 ***	-0,069	0,015	0,08	-0,153 ***	-0,070 *	0,08	-0,241 ***	-0,274 ***	-0,03	-0,156 *	-0,165 ***	-0,01
(2) HH wealth	-0,160 **	-0,282 ***	-0,12	-0,577 ***	-0,434 ***	0,14	-0,154 ***	-0,121 ***	0,03	-0,318 ***	-0,426 ***	-0,11	-0,342 ***	-0,318 **	0,02
(2) HH social	-0,188 *	0,074	0,26 **	-0,056	0,017	0,07	-0,142 ***	-0,061	0,08	-0,248 ***	-0,278 ***	-0,03	-0,169 **	-0,186 ***	-0,02
(3) HH wealth	-0,250 ***	-0,220 ***		-0,587 ***	-0,402 ***		-0,120	-0,156		-0,379 **	-0,233		-0,784 ***	-0,166	
(3) HH social	-0,391 ***	-0,035		-0,115	-0,029		-0,213 *	-0,065		-0,240	-0,299 *		-0,151	-0,170	
(3) HH wealth-Rural	0,267 *	-0,144		0,055	-0,056		-0,050	0,042		0,095	-0,434 **		0,724 ***	-0,266	
(3) HH social-Rural	0,260 *	0,126		0,078	0,061		0,105	0,006		-0,012	0,043		-0,032	-0,015	

*p < 0.10; **p < 0.05; ***p < 0.01.

(1) Without controls; (2) Controls for urban-rural residence; (3) Adds interaction between socioeconomic index and urban-rural residence.

[a]Household wealth index; [b]Interaction between household wealth index and place of residence.

[c]Household social index; [d]Interaction between household social index and place of residence.

[e]Community endowment index; [f]Interaction between community endowment index and place of residence.

Table 5. Estimates (coefficients) of the net socioeconomic effects on childhood malnutrition

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	1993	1999	Change	1991	1998	Change	1992	2000	Change	1993	1998	Change	1994	1999	Change
Model a: Without controls.															
HH wealth[a]	-0,150 **	-0,301 ***	-0,15	-0,563 ***	-0,426 ***	0,14	-0,151 ***	-0,113 **	0,04	-0,321 ***	-0,441 ***	-0,12	-0,343 ***	-0,314 **	0,03
HH social[c]	-0,181 *	0,072	0,25 **	-0,048	0,019	0,07	-0,142 ***	-0,061	0,08	-0,249 ***	-0,279 ***	-0,03	-0,169 **	-0,187 ***	-0,02
Com SES[e]	-0,098	0,171	0,27	-0,122	-0,049	0,07	-0,034	-0,110	-0,08	0,037	0,105	0,07	0,010	-0,040	-0,05
Rural residence	0,033	0,656	0,62	0,009	-0,050	-0,06	0,157	0,224	0,07	-0,221	-0,105	0,12	-0,294	-0,379	-0,09
Model b: Controls for household and mother covariates[1].															
HH wealth	-0,173 **	-0,307 ***	-0,13	-0,699 ***	-0,374 ***	0,33 **	-0,184 **	-0,108 *	0,08	-0,254 **	-0,378 ***	-0,12	-0,419 ***	-0,356 *	0,06
HH social	-0,170 *	0,073	0,24 **	-0,024	0,007	0,03	-0,114 **	-0,047	0,07	-0,231 ***	-0,254 ***	-0,02	-0,160 *	-0,181 **	-0,02
Com SES	-0,095	0,152	0,25	-0,145	-0,037	0,11	-0,014	-0,110	-0,10	0,039	0,054	0,02	0,033	0,022	-0,01
Rural residence	0,014	0,598	0,58	-0,183	-0,012	0,17	0,103	0,199	0,10	-0,170	-0,079	0,09	-0,430	-0,348	0,08
Model c: Expands Model b by adding child covariates[2].															
HH wealth	-0,195 **	-0,322 ***	-0,13	-0,576 ***	-0,311 ***	0,27 *	-0,139	-0,088	0,05	-0,209 **	-0,308 **	-0,10	-0,399 ***	-0,356 *	0,04
HH social	-0,131	0,071	0,20 *	0,010	0,033	0,02	-0,084	-0,034	0,05	-0,219 ***	-0,222 ***	0,00	-0,069	-0,104	-0,04
Com SES	-0,160 *	0,219	0,38	-0,153	0,049	0,20	-0,037	-0,105	-0,07	0,043	0,098	0,06	0,036	0,048	0,01
Rural residence	0,031	0,879	0,85	-0,140	0,120	0,26	0,003	0,152	0,15	-0,088	-0,164	-0,08	-0,431	-0,362	0,07
Model d: Expands Model c by adding interactions between urban-rural residence and each of the three socioeconomic indexes.															
HH wealth	-0,257 ***	-0,235 ***		-0,526 ***	-0,317 ***		-0,097	-0,077		-0,306 *	-0,255		-0,764 ***	-0,180	
HH social	-0,290 ***	-0,037		-0,019	0,026		-0,129	-0,013		-0,192	-0,154		0,037	-0,065	
Com SES	-0,096	0,203		-0,947 ***	0,031		-0,654 *	-1,002 **		0,329	0,147		-0,193	-0,585	
Rural residence	-0,046	0,763		-1,040 **	0,105		-0,401	-0,396		0,173	-0,216		-0,794	-0,336	
HH wealth-Rural[b]	0,253	-0,286		-0,029	0,011		-0,057	-0,011		0,144	-0,175		0,628 **	-0,354	
HH social-Rural[d]	0,210	0,125		0,045	0,006		0,062	-0,026		-0,033	-0,072		-0,126	-0,026	
Com SES-Rural[f]	-0,071	-0,042		0,871 **	0,056		0,649 *	0,947 **		-0,322	-0,216		0,227	1,071 *	

*p < 0.10; **p < 0.05; ***p < 0.01; [a, b, c, d, e, f]See Table 3.

[1]At the household level: the number of members and the number of under-five children, and their quadratic term; at the mother level: religion, exposure to media, current age, teenage first childbearing, and nutritional status.

[2]Current age, sex, low birth weight, antenatal care, place of delivery, age-specific immunization status, breast-feeding duration, and birth order/interval.

Note: Model e expanding Model c by adding interactions between each of the three socioeconomic indexes and child age (Not shown).

4.4. Gross estimates of socioeconomic influences on child malnutrition

Table 4 shows the multilevel estimates of each socioeconomic indicator fitted alone (Models a, b and c) and of the two household indexes fitted simultaneously (Model d). The third hypothesis of this work is about the inverse relationship between prevalence of child nutritional status and the SES of families and communities. As hypothesized, there is a strong inverse relationship between each of the three socioeconomic measures and child stunting, with statistically significant estimates in virtually all countries. Moreover, adding interaction with place of residence (Sub-model (3) in Models a to d) clearly indicates that socioeconomic inequalities in childhood malnutrition are consistently higher in urban centres than in rural areas. The coefficients however fails to reach statistical significance in Kenya for community SES (Model c), and in some instances in Model d.

Concerning the household wealth status (Model a), a control for the place of residence produces impact in line with expectations in Burkina Faso, Egypt and Cameroon where estimates diminish by 28%, 14%, and 7% respectively. In contrast, the effects of household wealth status on child's nutritional status are markedly on the rise in Zimbabwe (by 19%) and to a lesser degree in Kenya (7%). During the inter-survey period, wealth inequalities in child health tended to narrow in Cameroon, Egypt and Zimbabwe, and were somewhat on the rise in Burkina Faso and Kenya, without reaching statistical significance.

When place of residence is taken into account, the effects of household social status (Model b) on childhood stunting diminish sharply in Cameroon and Burkina Faso and slightly in the three other countries, but remain statistically significant ($p<0.05$ in Burkina Faso, $p<0.01$ in the other countries). Moreover, during the inter-survey period, inequalities in child health with respect to household social status have almost disappeared in Burkina Faso ($p<0.05$), have narrowed in Egypt and Cameroon, but have tended to widen in Kenya. When the effects of both household wealth and household social standings are considered simultaneously

(Model d), they are statistically significant in all countries except in Cameroon where the household social status has no significant influence on child health. The effects of the wealth status are slightly larger than those of the social status in all countries except in Burkina Faso. This finding adds to the debate on whether health inequalities among families primarily result from the effects of material hardship, or mainly reflect disparities with regard to social position, measured in this paper by mother's and father's education and occupation (Lynch and Kaplan, 2000).

With regard to the community SES (Model c), controlling for the location of residence sharply reduces the estimates between 33% (Cameroon) and 60% (Kenya), leading to loss of statistical significance in Egypt, Kenya and Zimbabwe. Though estimates for change fail to reach statistical significance, community socioeconomic inequalities have tended to widen during the inter-survey period in Kenya, Zimbabwe, and Egypt.

4.5. Net effects of household and socioeconomic influences on child malnutrition

Table 5 presents estimates of the influences of the three socioeconomic indexes taken together on childhood malnutrition with control for place of residence (Model a), household/mother attributes (Model b), child characteristics (Model c), and interaction effects between socioeconomic indexes and place of residence (Model d). In Model a, household wealth and household social statuses exhibit statistically significant inverse relationship with child's nutritional status in Burkina Faso, Egypt, Kenya and Zimbabwe, whereas only household wealth status reaches statistical significance in Cameroon ($p<0.01$). Adjustment for household/mother attributes (Model b) produces striking features. Whilst the effects of the household social status vary in the expected direction with a drop of 20% in Egypt, and a slight decrease (less than 7%) in Burkina Faso, Kenya and Zimbabwe, the effects of the household wealth situation are substantially on the rise by 15%-25% in all countries except in Kenya where they diminish by 20%.

When child characteristics are added to the estimated equation (Model c), some significant variations in the socioeconomic effects are noticed. The community socioeconomic effects increase sharply in Burkina Faso to reach statistical significance ($p<0.10$); household wealth estimates are on the rise in Burkina Faso whereas they decrease by 18%-24% in Cameroon, Egypt and Kenya, and by 5% in Zimbabwe. The effects of household social status further decline in all countries leading to a loss of statistical significance except in Kenya. Overall, household-, mother- and child-level controls contribute on the one hand to an increase of the household wealth effects in Burkina Faso and Zimbabwe by 30% and 16% respectively, and on the other to a drop in Kenya (by 35%) and Egypt (by 8%). The household social effects diminish markedly in Zimbabwe (by almost 60%), Egypt (by nearly 40%), Burkina Faso (by 28%), and Kenya (by 12%). Consequently, the relative contributions of the three socioeconomic measures and particularly the prominence of the household wealth index on child nutritional status become clear. Three patterns now emerge: household wealth status alone in Cameroon and Zimbabwe ($p < 0.01$); household wealth and social indices in Kenya (level of significance 0.05 for wealth, 0.01 for social); household wealth index and community SES in Burkina Faso (level of significance 0.05 for wealth, 0.10 for community SES); and none in Egypt.

Converting the estimated socioeconomic coefficients in Model c (Table 5) into odds ratio yields the following results. Malnutrition rates among children from the poorest 30% household wealth group are estimated to be almost 3.5 times higher in Cameroon, and 2.5 times higher in Zimbabwe, than among their counterparts in the richest 30% household wealth group. This poor/rich ratio averages 1.4 in the other countries (Burkina Faso, Egypt and Kenya). As regards the household social status, the likelihood of malnutrition among children from the poorest 30% group is 1.6 times higher in Kenya than among those from the richest 30% group. For the community SES, malnutrition rates in Burkina Faso are almost 45%

higher among children in deprived communities than among those in the most privileged areas. Moreover, during the inter-survey period, inequalities among communities in child malnutrition have tended to narrow in Cameroon and to widen in Egypt; household wealth inequalities have lowered in Cameroon, Egypt and to a lesser degree in Zimbabwe, and tended to be on the rise in the two other countries; household social inequalities have significantly narrowed in Burkina Faso ($p<.10$).

Finally, interaction effects between place of residence and each of the three SES are added in the most complete model. It appears from this full model with interactions that community SES is strongly associated with urban childhood malnutrition in Cameroon and Egypt. Overall, these results tend to support the main finding of a steeper socioeconomic gradient in child nutritional status in urban centres than in rural areas, as shown in the descriptive analyses using concentration index (Figure 4 to 6).

We also fitted a Model e which expands Model c by adding interactions between child age (dichotomized as 3-23 months and ≥ 24 months) and each of the three socioeconomic measures (results not shown). No significant interaction term emerged except in Egypt (2000) and Kenya (1998) where the interaction between household wealth index and child age reached statistical significance at the level of 0.01 and 0.05 respectively. Furthermore the coefficients were negative, indicating higher explanatory power of the household wealth index to predict the nutritional status of children aged 24 months and older to in these two countries and time periods.

5. Discussion

This study has examined the relative contributions of compositional and contextual effects of urban-rural place of residence and socioeconomic status (SES) in explaining malnutrition

among children in Africa, using a coherent analytic framework and multilevel modelling approaches. A number of findings emerge from this work.

The gap in the prevalence of child malnutrition between better-off and disadvantaged groups remains wide. The SES of communities and households are significantly associated with childhood stunting, with household wealth emerging as the strongest predictor and the community SES playing in some instances an independent and important role. The socioeconomic situation of individuals and communities affects a broad array of characteristics, conditions and experiences, which in turn are likely to affect their health and nutritional status. The community SES plays a sizeable role in affecting health status, presumably through its influences on the SES of individuals and the social service and physical environment of communities shared by residents (Robert, 1999; Cortinovis et al., 1993; Mosley & Chen, 1984). Although cross-study comparisons are rendered difficult because most previous studies have typically use their own SES indicators, this work yield consistent evidence across countries and over time of better nutritional status among children from parents privileged by more education and jobs, from wealthier households or from the most affluent areas. The relationships between SES and stunting are weaker in Zimbabwe especially in the second time period (1999), as can been noticed in the descriptive as well as multivariate analyses. However, data on the quality of the constructed socioeconomic indexes as measured through the proportion of variance explained by the first principal component and through the internal coherence (not shown), do not reveal any evidence of poorer adjustment in Zimbabwe (for details, see Fotso & Kuate-Defo, 2004).

The strong evidence of variations in child malnutrition among communities is consistent with the presence of contextual and socio-environmental effects. This finding, in line with most studies that attempt to disentangle contextual from compositional effects (Subramanian et al., 2003; Reed et al., 1996), lends support to the growing evidence on the influences of living

conditions in health and nutrition research (Alvarez-Dardet, 2000; Pickett & Pearl, 2001). Moreover, including community SES and place of residence in fitted models resulted in an increase of the amount of the between-community variance in Cameroon (both periods), Egypt (1992), and Kenya (both periods). It may be conjectured that controlling for urban-rural place of residence and community SES reveals important differences in unmeasured familial characteristics by community of residence that were previously obscured and/or revealed important unmeasured differences among communities. When both individual and area level predictors were entered in the model, the intra-community correlation ranges from nearly 3% in Burkina Faso to almost 12% in Cameroon. The existence of such unobserved heterogeneity suggests that other key community correlates not included in the analyses also significantly influence child nutrition.

This study also confirms the evidence from most previous studies that have consistently reported that urban children are significantly less likely than rural ones to become malnourished (Kuate-Defo, 2001; Tharakan & Suchindran, 1999; Adair & Guilkey, 1997; Ricci & Becker, 1996). Furthermore, it shows that this urban advantage is essentially accounted for by the SES of communities and families, which probably points to a stronger explanatory power of the standardized socioeconomic measures developed and used in this study. Thus, as suggested by Smith et al. (2004), better nutritional status of urban children is probably due to the cumulative effects of a series of more favourable socioeconomic conditions, which in turn, seems to positively impact on caring practices for children and their mothers. Finally, an assessment of the extent to which differences in nutritional status among children arising from interactions between SES and place of residence consistently indicates that socioeconomic gradient in child health is steeper in urban centres than in rural areas, or stated in other words, that large differentials exist among socioeconomic groups in urban areas. These patterns also emerged from works of Menon et al. (2000) based on 11 developing countries across Africa, Asia and Latin America, which suggest that reliance on

global average statistics to allocate resources between rural and urban areas may be misleading. They are clearly supportive of the advocacy for programs and policies targeting the nutrition situation of the population living in poor urban areas (Menon et al., 2000), since African continent is witnessing a rapid urbanization accompanied in most countries by severe economic deceleration, leading to poor livelihood opportunities, worsening health conditions, and growing poverty.

Appendix 1. Definitions and specifications of variables used in analyses

Variable	Operational definition, specification and explanations
Stunting	Dummy variable coded 1 if the child's height measurement in relation to his age is more than 2 standard deviations below the median reference of the WHO/NCHS/CDC[1]
	Panel B: Independent variables (Socioeconomic indices[2])
1. Household Wealth index	Constructed from household's ownership of a number of durable goods (electricity, radio, TV, refrigerator, bicycle, motorcycle, car, oven, stove, and telephone), type of drinking water source, toilet facilities and flooring material. The latter three indicators are recoded 0-1 in terms of access to clean water, to modern toilets, to finished floor respectively.
2. Household Social index	Constructed from a set of dummy variables related to mother and father education and occupation. Education is coded 0 (no education); 1 (primary); and 2 (secondary and more). Occupation is coded 0 (no occupation); 1 (works in the agricultural sector); and 3 (works in the other sectors).
3. Community endowment index	Constructed from the proportion of households having access to electricity, to telephone, to cleaned water, along with relevant community-level characteristics such as access roads, sewerage system, distances to different socioeconomic infrastructures (schools, markets, regular transportation services, postal services, banks, health services, pharmacy) when available.
	Panel C: Selected control variables[3]
1. Media exposure	Dummy variable coded 1 if mother has access to radio or television at home.
2. Teenage childbearing	Dummy variable coded 1 if index child's birth occured before the age of 20 years.
3. Nutritional status of the mother	Dummy variable coded 1 if mother's body mass index (BMI) is less than 18.5, a cut-off recommended for assessing chronic energy defiency among non-pregnant women.
4. Antenatal care	Dummy variable coded 1 if child's mother received at least one antenatal care from a medically trained person during pregnancy.
4. Place of delivery	Dummy variable coded 1 if the child was delivered in a health center.
6. Immunization status	Dummy variable coded 1 if the child is fully immunized for his age. We use the following age schedule for infant vaccination derived from the Expanded Program on Immunization set by the WHO[1]: BCG at birth; DPT and oral Polio at 2, 3 and 4 months; Measles at 9 months.
7. Birth order and interval	Combination of birth order and preceding birth interval in five categories: (i) first, (ii) 2^{nd}-3^{rd} and <24 months, (iii) 2^{nd}-3^{rd} and >=24 months, (iv) 4^{th}+ and <24 months, (v) 4^{th}+ and >=24 months

[1]World Health Organization/National Center for Health Statistics (USA)/Center for Disease Control (USA).

[2]The three socioeconimic indexes are continuous variables. However, when necessary they are categorized according to quintile values.

[3]The other covariates which need no further specification include: (i) at the community level, urban-rural residence; (ii) at the household level, the number of members and the number of under-five children, and their quadratic term; (iii) at the mother level, religion and current age; and (iv) at the child level, current age, sex, low birth weight and breast-feeding duration.

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Chapitre 3

Socioeconomic inequalities in early childhood malnutrition and morbidity: Modification of the household-level effects by the community socioeconomic status

Socioeconomic Inequalities in Early Childhood Malnutrition and Morbidity: Modification of the Household-level Effects by the Community SES

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Health and Place, in press

Abstract

This paper examines variations among communities in childhood malnutrition and diarrhea morbidity, explores the influences of socioeconomic status (SES) on child health, and investigates how the SES of families and that of communities interact in this process. Using multilevel modelling and data from Demographic and Health Surveys of five African countries, it shows evidence of contextual effects and a strong patterning in childhood malnutrition and morbidity along SES lines, with community socioeconomic SES having an independent effect in some instances. It also reveals that living in poorest conditions increases the odds of suffering from both malnutrition and diarrhea, as opposed to experiencing only one of the two outcomes. Importantly, community SES significantly modifies the effects of the household SES, suggesting that measures to improve access of mothers and children to basic community resources may be necessary preconditions for higher levels of familial socioeconomic situation to contribute to improved child health.

Key words: Socioeconomic inequalities, Malnutrition, Diarrhea morbidity, Multilevel models, Cross-level interaction, Africa

1. Background

Malnutrition and infectious diseases among preschoolers feature prominently among the major public health concerns in developing countries (UNICEF, 1998; WHO, 1999; Kuate-Defo, 2001). Childhood malnutrition is widespread and is associated with increased susceptibility to disease and risk of mortality, and with poor mental development and learning ability. There is also a growing evidence of reduced work efficiency and poor reproductive outcomes among individuals who experienced persistent malnutrition during childhood (De Onis et al., 2000; UNICEF, 1998; Adair and Guilkey, 1997; Wagstaff and Watanabe, 2000). On the other hand, diarrhea and acute respiratory infections are contributing factors to malnutrition and major causes of morbidity and mortality among preschoolers in the third world. The burden of diarrhea is highest in deprived areas where there is poor sanitation, inadequate hygiene and unsafe drinking water, and ARI often affects children with low birth weight or those whose immune systems are weakened by malnutrition or other diseases (WHO, 1999, Forste, 1998). Consequently, children living in impoverished familial or residential environments are caught in a vicious circle of poor nutrition, impaired immune function and barrier protection, and increased susceptibility to infectious diseases, leading to decreased dietary intake, immunological dysfunction and metabolic responses that further alter their nutritional status (Brown, 2003; Tomkins and Watson, 1989; Scrimshaw et al., 1968; Chandra, 1997).

The causes of malnutrition and morbidity are diverse, multi-sectoral, interrelated and entail biological, social, cultural and economic factors, and their influences operate at various levels such as child, family, household[1], community[2] and nation. The socioeconomic statuses of

[1] In this paper, the term "Household" is used interchangeably with "Family".

individuals, households and communities are basic determinants of child health, since poverty remains the root cause of the more proximate correlates such as limited access to education, health care and foods, as well as poor environment and housing, and large family size (Gopalan, 2000; Emch, 1999; FAO, 1997). Empirically, a large body of research has documented inverse relationship between SES and a variety of health outcomes over time and in different countries, regardless of the measure of the SES (Kuate-Defo, 2001; 1996; Adair and Guilkey, 1997; Ricci and Becker, 1996; Emch, 1999). Furthermore, researchers and policy makers increasingly recognize that although human health has improved in the past decades, the gap between rich and poor remains very wide just as it does also between the better-off and disadvantaged groups defined, for example, by place of residence, education, and job status. Addressing the problems of inequalities in child health, both between countries and within countries, remains therefore one of the greatest challenges, and is of special appeal for policies and programs targeting child's welfare and survival (Feachem, 2000).

Unfortunately, the literature on these topics is built mainly on evidence from industrialized countries (Alvarez-Dardet, 2000). For developing countries research on these issues has focused mainly on mortality, and there has been comparatively very little research regarding morbidity or malnutrition. Importantly, in the absence of standard conceptualization and measurement of SES, researchers have typically used their own socioeconomic indicators, thus making comparisons highly difficult. Moreover studies in this area are rarely based on nationally representative data within a comparative perspective, and their modelling strategies often ignore the hierarchical structure of the data.

Against this background, this study is designed in an attempt to examine variations among communities in childhood malnutrition and morbidity, and to investigate how the SES of

[2] The term community, area and neighborhood are used interchangeably to refer to a person's residential environment which is hypothesized to have characteristics potentially related to health.

communities and that of households affect child health regardless of their individual characteristics, and how they interact in this process (Robert, 1999; Diez-Roux, 2001; 1998; Duncan et al., 1998; 1996). More specifically, the motivation is to test the following hypotheses: (i) Childhood malnutrition and diarrhea morbidity cluster among communities, according to patterns consistent with the presence of contextual effects; (ii) Malnutrition and diarrhea morbidity occur more frequently among children from households and communities with lower SES; (iii) The household socioeconomic influences on child health are modified by the SES of communities.

The first hypothesis relates to the presence of contextual effects in explaining child health, since the variation among communities may arise from compositional effects with particular types of people, who are more likely to experience poor health due to their individual characteristics, being found more commonly in particular communities or households (Kuate-Defo and Diallo, 2002; Pickett and Pearl, 2001; Macintyre et al., 1993). Our second hypothesis pertains to the association between health status and SES that has been so widely documented in variety of settings and contexts, with special interest in examining the independent influence of the community SES over and above the effects associated with household SES (Robert, 1999; Diez-Roux, 2001; Duncan et al., 1998), and in exploring evidence of co-occurrence between malnutrition and morbidity, since both outcomes theoretically influence each other (Brown, 2003; Tomkins and Watson, 1989; Scrimshaw et al., 1968). The third hypothesis is about potentially interactive effects whereby the socioeconomic position of families and those of their communities of residence interact to produce substantively different expression of child health outcomes (Robert, 1999; Gordon et al., 2003; Sastry, 1996).

The remainder of this paper is divided into four sections: The first sets out a conceptual framework for the analysis of household and community socioeconomic influences on child health, followed by a presentation of the data and methods used in this work. Results of the analyses are object of a third section, and the main findings are outlined and discussed in a concluding section.

2. Conceptual framework

Along the lines of Mosley and Chen's (1984) and UNICEF's (1990) frameworks, we postulate that socioeconomic factors at different levels (community, family) operate through more proximate determinants to influence child's nutritional and morbid statuses, as depicted in Figure 1. These factors include: (i) household size and composition that may be measured by both the total number of its members and especially those under five years of age as well as the gender composition of the household; (ii) access to and utilisation of health care services, especially for antenatal care, delivery and immunization of children; (iii) mother's nutritional behaviour and status proxied by breastfeeding patterns and body mass index; (iv) mother's reproductive patterns and cultural practices, encompassing age at puberty, age at sexual debut, age at maternity, birth spacing practices, religious affiliation and religiosity, and exposure to media; and (v) child's characteristics, prominent among which are biological variables such as age, sex, birth weight, gestational length, health conditions at birth, and birth order. The literature yields mounting evidence of the effects of these factors on child's health (Adair and Guilkey, 1997; Kuate-Defo, 2001; Ricci and Becker, 1996; Forste, 1998; Cebu Study Team, 1991).

2.1. Socioeconomic factors

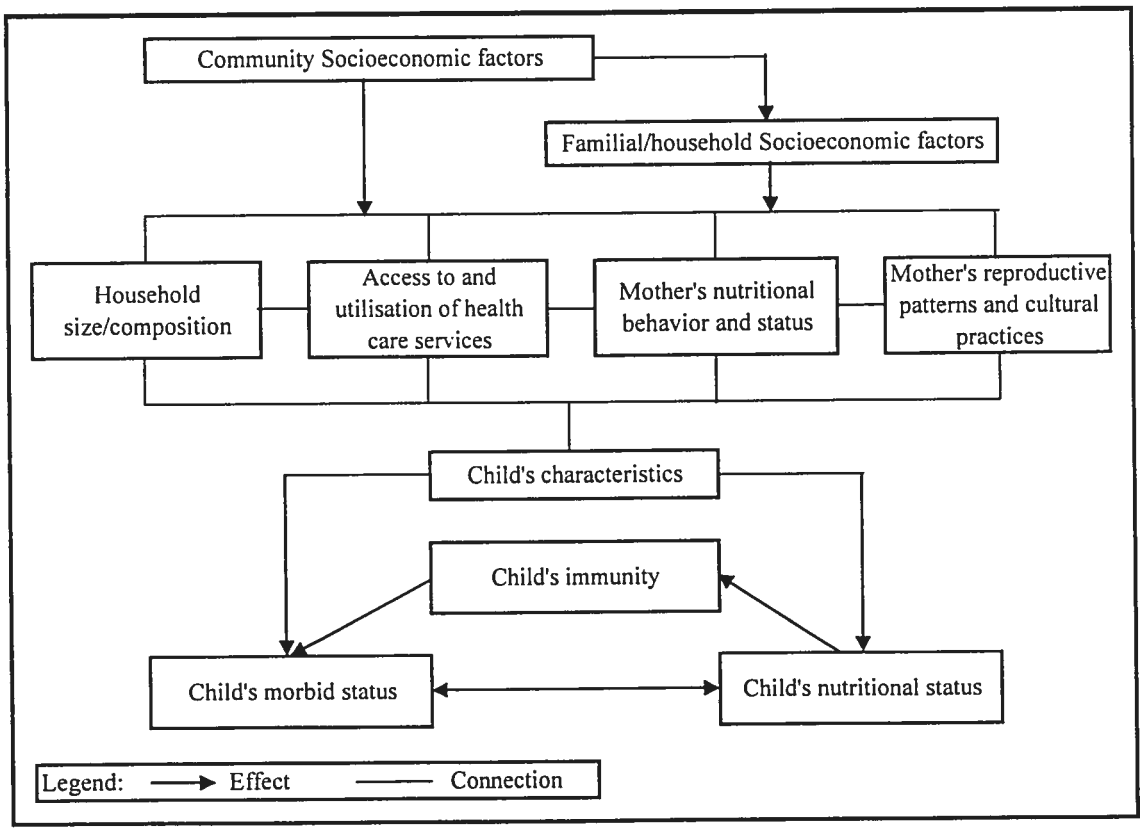
The socioeconomic factors that influence child health include family-level variables such as education and employment, income and ownership of consumer durable goods, type of

drinking water, sanitation and housing; as well as community-level covariates captured by the availability of health-related services and relevant socioeconomic infrastructures. A number of studies (Armar-Klemesu et al., 2000; Bicego and Boerma, 1993; Dargent-Molina et al., 1994; Sandiford et al., 1995) have supported the general evidence that maternal schooling is a stronger determinant of child welfare in developing countries, estimated to influence her choices and to increase her skills and behaviours related to preventive care, nutrition, hygiene, breastfeeding, among others. Empirically, educated women are more likely to take advantage of modern health care services in caring for their children, and are more aware of the nutritional problems their children may face, while in contrast, inadequate or improper education often exacerbates women's inability to generate resources for improved nutrition for their families (Mosley and Chen, 1984; UNICEF, 1990; Kuate-Defo and Diallo, 2002). The household socioeconomic factors mainly influence its member's health through the financial ability to secure goods and services that promote better health, help to maintain a more hygienic environment, and ensure adequate nutrition needs. For example, lack of ready access to water and poor environmental sanitation are important underlying causes of both malnutrition and diseases. The presence of electricity, radio, television, the availability of transportation means as well as housing – both size and quality - also feature prominently among the household-level determinants of child's health (Mosley and Chen, 1984; UNICEF, 1990; Kuate-Defo, 2001).

As shown in the framework depicted in Figure 1, community socioeconomic may influence child health and survival by shaping the family/household-level SES, or by directly affecting the social, economic and physical environments shared by residents, which in turn operate through more proximate attributes to impact on health outcomes (Mosley and Chen, 1984; Robert, 1999). In effect, health-related services and other socioeconomic infrastructure such as schools and markets, public services such as electricity, water, sewerage, transportation and

telephone networks, are likely to be quite inadequate in lower socioeconomic communities with often deleterious consequences on child's health. And even when these basic services and foods may be available in deprived areas, their access may be hampered by barriers such as inadequate or unsafe transportation systems (Mosley and Chen, 1984). An often made critique of cross-sectional studies investigating contextual effects of neighbourhood is that people may be selected into communities based on values of the outcome being investigated, especially when the outcome under study or some of its factors may influence where people can or choose to live. For instance, Sastry (1996) and Robert (1999) suggested that community-level services and infrastructure may be determined endogenously as they may be located in areas of especially high prevalence of ill-health outcomes, or individuals may choose to migrate to communities on the basis of their demand for a particular mix of community services and amenities. However, community variables are treated as exogenous in the present study because of the absence of data to apply appropriate corrections.

Figure 1. Conceptual framework for the analysis of household and community socioeconomic influences on child health



2.2. Effects modification: Cross-level socioeconomic interactions

Of particular importance in this study is the investigation on potentially interactive effects whereby the socioeconomic position of families and those of their communities of residence interact to produce substantively different expression of child health outcomes, or more precisely, the extent to which community factors moderate, exacerbate or mitigate the effects of the household SES on child health (Duncan et al., 1998; Robert, 1999; Gordon et al., 2003; Sastry, 1996). Assignment of community SES and household SES to what Jaccard (2001) refers to as *moderator variable* and *focal variable* respectively, may seem arbitrary in a general context since as did Sastry (1996), one may wish to examine whether household socioeconomic factors modify the effects of community characteristics. In a multilevel context however, investigating effects modification by community-level factors is probably more compelling, as many of the conceptual frameworks are driven by the assumption that higher levels constructs moderate the effects of lower levels factors (Gordon et al., 2003). Our research question also pertains to issues of community characteristics complementing or substituting for certain household attributes (Sastry, 1996), of *double jeopardy* or *relative deprivation* (Robert, 1999). More specifically, it relates to whether higher community SES lessens or even eliminates, or alternatively initiates or enlarges the effects of the household SES on child health. Gordon et al. (2003) refer to these patterns as *lessening/eliminating* model and *initiating/enlarging* model respectively.

2.3. Co-occurrence of malnutrition and morbidity

Since the publication of the World Health Organization monograph by Scrimshaw et al (1968), studies in the field of malnutrition and diarrhea have generally been carried out in one of the three major areas: (i) nutritional risk factor for diarrhea (Etiler et al., 2004; Emch, 1999); (ii) effects of diarrhea on nutritional status (Adair and Guilkey, 1997; Tharakan and Suchindran, 1999; Madise et al., 1999); and (iii) dietary management of patients with diarrhea

(Brown, 2003). With cross-sectional data, it may not be very meaningful to tease apart the independent effects of malnutrition on infection and vice-versa, since both outcomes are potentially endogenous variables. It may be more appropriate to investigate the correlates of the presence of malnutrition alone, diarrhea alone, or the two together.

3. Data and methods

3.1. Data

To achieve the objectives of this study, we use data from the Demographic and Health Surveys (DHS) of five African countries which have carried out more than one DHS in the 90s: Burkina Faso (1992/93, 1998/99); Cameroon (1991, 1998); Egypt (1992, 2000); Kenya (1993, 1998) and Zimbabwe (1994, 1999). The selected countries exhibit quite different socioeconomic and demographic profiles, with Burkina Faso being one of the least developed country and Egypt by contrast, one of the most affluent. Hence, although they are not representative of the entire African continent, their geographic location (West, Central, North, East and Southern Africa) and socioeconomic and cultural diversities constitute a good yardstick for the continent and may allow us to draw some robust inferences. Basically, the DHS retrieve detailed nutrition and health related information on women aged 15-49 years and their children born in the three or five years preceding the survey date, and on relevant child, mother, household and community characteristics. From here we refer to the first and second surveys in each country as DHS-1 and DHS-2 respectively.

3.1.1. Dependent variables: Nutritional and morbid statuses of children

Among various growth-monitoring indices, there are three commonly used comprehensive profiles of malnutrition in children namely stunting, wasting and underweight, measured by height-for-age, weight-for height, and weight-for-age indexes respectively. More specifically, stunting or growth retardation, or chronic protein-energy malnutrition (PEM) results in young

children from recurrent episodes or prolonged periods of nutrition deficiency for calories and/or protein available to the body tissues, inadequate intake of food over a long period of time, or persistent or recurrent ill-health. Wasting or acute PEM captures the failure to receive adequate nutrition during the period immediately before the survey, resulting from recent episodes of illness and diarrhea in particular, or from acute food shortage. Underweight status is a composite of the two preceding ones, and can be due to either chronic or acute PEM (Kuate-Defo, 2001). As recommended by the World Health Organization, children whose index is more than two standard deviations below the median NCHS/CDC/WHO[3] reference population are classified as malnourished, that is stunted, wasted or underweight depending on the index used.

For children's morbid status, DHS data provide information based on mothers' reports regarding fever, diarrhea or coughing accompanied by short, rapid breathing during the two-week period preceding the survey, the latter referring to acute respiratory infections (ARI). The present paper focuses on stunting, underweight and diarrhea, as wasting[4] is generally of very low prevalence, and ARI more subject to missing values (close to 70% in Burkina Faso, Cameroon and Egypt in their DHS-1). Boerma et al. (1992) showed that the survival bias - since only children who survive are taken into account - could be ignored in studies using anthropometrics indicators. Finally, to test for the co-occurrence of malnutrition and morbidity, two variables referred to as stunting-diarrhea and underweight-diarrhea are defined as follows:

$$y = \begin{cases} 0 & \text{if the child suffers from neither malnutrition nor diarrhea} \\ 1 & \text{if the child suffers from malnutrition or (exclusive) from diarrhea} \\ 2 & \text{if the child suffers from both malnutrition and diarrhea} \end{cases}$$

[3] US Center for Health Statistics/US Center for Disease Control/World Health Organization.

[4] A number of studies have shown that wasting is volatile over seasons and periods of sickness (World Bank, 2002).

3.1.2. Defining community

An important issue in studies dealing with area effects on health is the definition of communities or neighbourhoods or, more precisely the geographic area whose characteristics may be relevant to the health outcome under study. Of the many health-based studies in developing countries using community-level characteristics, very few have provided a concise definition of community. For research in industrialized countries, administratively defined areas have often been used as rough proxies for communities or neighbourhoods. Conceptually, the size and definition of community may vary according to the processes through which area effect is hypothesized to operate and to the health outcome studied (Diez-Roux, 2001). Nevertheless, researchers working with large national-representative samples often have no choice but to rely on administrative definitions for which standard data are available, even though these structures may have no explicit theoretical justification in terms of the outcome under consideration (Duncan et al., 1998). Consequently, we have defined community by grouping sampling clusters within administrative units[5].

3.1.3. Independent variables: Socioeconomic status

Despite the overwhelming interest and progress on SES in health-related research, there is still no consensus on its nominal definition or a widely accepted measurement tool (Lynch and Kaplan, 2000; Campbell and Parker, 1983; Cortinovis et al., 1993; Oakes and Rossi, 2003). In this context the general approach has been to use different individual-, household- or community-level indicators including maternal education, household income or possessions, land ownership, water and sanitation, flooring material, place of residence, although Cortinovis et al. (1993) and Durkin et al. (1994) have attempted to draw awareness on the need to construct overall socioeconomic indexes rather than using individual

[5] The numbering of clusters (primary sampling units) in the DHS does reflect their proximity since before the selection process, they are ordered geographically within the hierarchy of administrative units. Our grouping of clusters was done in order to have a desirable minimum of 8 households per community and a number of communities totalling a minimum around 30 in each urban and rural samples.

indicators, as stressed by Campbell and Parker (1983). Methodologically, when covariates are strongly collinear as are likely to be socioeconomic factors, it may be very difficult and perhaps not very meaningful to tease apart their independent effects. Other shortcomings of current approaches concern the ignorance of father's education, despite the fact in many societies of the developing world, the husband generally makes decision regarding fertility, contraception and use of health care services, so that certain behaviours and practices which may affect child health and nutrition depend on the father and specifically on his level of education (Kuate-Defo and Diallo, 2002).

Along the lines of Gwatkin et al. (2000), Filmer and Pritchett (2001) and within the framework developed above which recognizes the distinctive feature of socioeconomic indexes measured at the household versus community levels, we have constructed three relevant and complementary socioeconomic indexes using principal component analysis: (i) Household wealth index that captures household's possessions, type of drinking water source, toilet facilities and flooring material, and thus may be used as proxy for the commonly used income or expenditures variables; (ii) Household social index, that encompasses maternal and paternal education and occupation; and (iii) Community SES, defined from the proportion of households having access to electricity, telephone and cleaned water, together with relevant community-level information retrieved from community surveys when available[6]. Besides distinguishing socioeconomic factors by level of influence, it is of special interest to examine whether socioeconomic inequalities in health are mainly attributable to factors related to poverty and material hardship, or to factors such as education, employment status and other indicators of social status that are likely to causally precede income and wealth (Rahkonen et al., 2002; Lynch and Kaplan, 2000). The two household indexes seek to further our understanding of this issue. The three socioeconomic indexes are continuously centered

[6] They were carried out only for DHS-1 (Egypt carried out no community survey).

variables. In the descriptive analyses however, households and communities are assigned to five 20% quintile groups and classified hereinafter as poorest (bottom 20%), low (next 20%), middle (next 20%), high (next 20%) and richest[7] (top 20%).

In a previous paper (Fotso and Kuate-Defo, in press), we showed that each of these socioeconomic indexes is internally coherent, in that it produces sharp separations across its quintile groups for each of the indicator used in its construction, indicating their high degree of summarizing information contained in the assets variables. The explanatory power of the indexes was then evaluated on various health outcomes including health care services utilization (antenatal care, immunization), malnutrition (stunting, underweight), and mortality (infant mortality, under-five mortality). The association generally exhibited remarkable socioeconomic gradients in each of the five selected countries and survey period.

3.1.4. Measuring inequalities in child health

There is a great deal of discussion on measures of health inequalities in the scientific literature, with two distinct approaches: defining relevant a priori groups and then examining the health differentials between them; or alternatively, measuring the distribution of health status across individuals in a population, analogous to measures of income distribution in a population. The former only looks at between-individual differences that are linked to differences in groupings, whilst the latter does disregard relevance groupings and then prevents inquiries into the causes of health inequalities (Kawachi et al., 2002; Wagstaff and Watanabe, 2000). Thus in this paper, we use the first approach and calculate concentration indexes as proxies for familial and community socioeconomic inequalities in child health. The concentration curve plots the cumulative proportions of the population (beginning with the most disadvantaged[8]) against the cumulative proportion of health. The resulting concentration

[7] These labels are used for pure expository purposes, and not following a definition of poor and rich.
[8] Continuous socioeconomic indexes are used in this paper.

index[9] varies from -1 to +1, and measures the extent to which a health outcome is unequally distributed across groups (Wagstaff et al., 1991). Since the indices of inequalities in health are generally estimated from sample observations, it is useful to test their statistical significance. The concentration index and its variance are calculated according to the following formulae due to Kakwani et al. (1997):

$$\begin{cases} C = \dfrac{2}{n\mu}\sum_{i=1}^{n} y_i R_i - 1 \\ Var(C) = \dfrac{1}{n}\left[\dfrac{1}{n}\sum_{i=1}^{n} a_i^2 - (1+C)^2\right] \\ a_i = \dfrac{y_i}{\mu}(2R_i - 1 - C) + 2 - q_{i-1} - q_i \end{cases}$$

Where C is the concentration index; n is the sample size; y_i refers to the dummy variable of interest (stunting, underweight or diarrhea in our case); R_i is the relative rank of the individual i; μ is the mean of y; q_i is the cumulative proportion of y $\left(q_i = \dfrac{1}{n}\sum_{k=1}^{i} y_i\right)$

3.2. Statistical methods

DHS data typically have a hierarchical structure due mainly to randomly sampling naturally occurring groups in the population, with children nested within mothers, mothers clustered within household and household nested within communities. As a result, observations from the same group are expected to be more alike at least in part because they share a common set or characteristics or have been exposed to a common set of conditions, thus violating the standard assumption of independence of observations inherent in conventional regression models. Consequently, unless some allowance for clustering is made, standard statistical methods for analyzing such data are no longer valid, as they generally produce downwardly biased variance estimates, leading for example to infer the existence of an effect when in fact

[9] The concentration index is similar to the Gini coefficient frequently used in the study of income inequalities. The closer is the index to zero, the less unequally distributed among socioeconomic groups is the health outcome and conversely, the further away is the index from zero, the more concentrated is the socioeconomic inequality. The sign of the index reflects the expected direction of the relationship between the SES and the health outcome (Gwatkin et al., 2000; Wagstaff et al., 1991).

that effect estimated from the sample could be ascribed to chance (Duncan et al., 1998; Rasbash et al., 2002). Moreover, as pointed out in the framework depicted in Figure 1, to gain a more complete understanding of the influences of SES on child health, we need to consider the child, mother, household and community levels simultaneously.

Multilevel models provide a framework for analysis which is not only technically stronger but which also has a much greater capacity for generality than traditional single-level statistical methods, while circumventing *ecological* and *atomistic fallacies* (Duncan et al., 1998). Briefly, in addition to accounting for the hierarchical structure of the data and allowing efficient estimation of variation at each level, these methods are explicitly designed to enable to disentangle strictly contextual effects from compositional ones, and also to investigate through cross-level interactions how the effects of individual-level factors are modified by group-level variables. The DHS data form a hierarchical structure with four levels: children, mothers, households and communities. However, with an average of 1.5 under-five children per mother and 1.2 mothers of under-five children per household in our data, we define a family level by collapsing chid-, mother- and household-level data. Consequently, we use two-level (child and community) binary logistic regression analyses with the dichotomous outcome variables which are stunting, underweight and diarrhea, according to the following equations:

$$\begin{cases} Logit(\pi_{ij}) = \ln\left[\dfrac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_{0j} + \sum_{k=1}^{p}\beta_k x_{ij}^{(k)} + \sum_{l=1}^{q}\delta_l z_j^{(l)} + \sum_{k=1}^{r}\sum_{l=1}^{s}\lambda_{kl} x_{ij}^{(k)} z_j^{(l)} \\ \beta_{0j} = \beta_0 + u_{0j} \end{cases}$$

In these equations, i and j refer to the family and community respectively; π_{ij} is the probability that child referenced (i, j) is stunted, underweight or has had diarrhea (depending on the outcome studied); $x_{ij}^{(k)}$ and $z_j^{(l)}$ are the k^{th} family-level covariate and the l^{th} community-level covariate respectively; β_{0j} is the constant term modelled to randomly vary among

communities; the β_k and the δ_l represent the regression coefficients of the familial explanatory variables and the community explanatory variables respectively; the λ_{kl} refer to the coefficients for the cross-level interaction terms[10]; and u_{0j} and e_{0ij} are the random community residuals and random familial residuals respectively, distributed as $N(0,\sigma^2_{u0})$ and $N(0,\sigma^2_{e0})$ respectively. Being at different levels, they are supposed independent from each other (Snijders and Bosker, 1999; Rasbash et al., 2002). Models are fitted using the MLwiN software (Rasbash et al., 2002) with Extra-binomial and Marginal Quasi Likelihood (MQL) first-order linearization procedures.

For the multi-category dependent variables (stunting-diarrhea and underweight-diarrhea), polytomous logistic regression models are used to fit two logit functions with suffering from neither malnutrition nor diarrhea as reference category. We exclude from the analyses observations with missing values on dependent variables for each relevant model. Sampling probabilities are used in all our analyses to weight information at the individual level, so that the resulting findings are generalized to the total population. In effect, DHS surveys often over-sampled certain sub-groups in order to obtain statistically meaningful sample sizes for analysis. Moreover, all continuous variables are centered around the grand mean.

Methodologically, we achieve the goals of the study through five models. The first one is a null model (Model 1) which provides information on the extent to which communities vary in their outcomes before account is taken for any control variable, whilst Model 2 controls for all the level 1 variables in order to test the existence of contextual effects. Model 3 is about the gross socioeconomic effects on child health (it includes place of residence and the three socioeconomic measures without any control), and Model 4 expands Model 3 by adding household, mother and child covariates. We assess changes over time by comparing the

[10] r is less than p, and s is less than q since we do not model all the possible cross-level interactions.

coefficients between the two survey periods[11]. Finally, Model 5 includes cross-level socioeconomic interactions. From the interaction coefficients therein, we derive conditional household socioeconomic effects according to the community SES. The control variables include at the household level, the number of household members and the number of under-five children (both continuous centered variables); at the mother level, religion, exposure to media (radio or television), current age, teenage childbearing, and nutritional status; and at the child level, current age, sex, low birth weight, antenatal care, place of delivery, age-specific immunization status, breast feeding duration, birth order and birth intervals.

4. Results

For descriptive analyses, Figures 2 to 4 display the association between SES and childhood malnutrition and diarrhea morbidity in the DHS-1; Figure 5 shows the prevalence of the three outcomes, and Figures 6 to 8 illustrate the socioeconomic inequalities in child health. Multivariate analyses are in Table 1 (stunting), Table 2 (underweight), Table 3 (diarrhea), Table 4 (stunting-diarrhea) and Table 5 (underweight-diarrhea), whilst conditional effects are in Table 6 (household wealth status) and Table 7 (household social status). We present below the main findings emerging from these results, focusing primarily on the first survey (DHS-1) and referring to DHS-2 when evaluating changes over time.

4.1. Descriptive analyses: Socioeconomic inequalities in child health

To a large extent, Figures 2 to 4 exhibit remarkable socioeconomic gradients irrespective of the measure of SES and the country, as rates of malnutrition and diarrhea generally decline steadily with increasing SES, though relationships for diarrhea are weaker on the whole. Analogous patterns are observed in the DHS-2 as well (Figures not shown). Estimates for the prevalence (Figure 5) forcefully indicate that malnutrition and diarrhea morbidity are highly

[11] Calculation of the standard deviation of change is based on the assumption of independence of the DHS-1 and DHS-2 samples in each country. This may not be the case strictly-speaking, since some households may be selected in both samples.

prevalent in the selected countries. From the DHS-1, stunting affects between 22% (Zimbabwe) and nearly 35% (Burkina Faso and Kenya) of young children, and underweight between 10% (Egypt) and 33% (Burkina Faso), whilst diarrhea prevalence ranges from 13% (Egypt) to almost 25% in Zimbabwe. As regards change over time, the situation of child health has generally worsened in Burkina Faso and Cameroon, and in contrast, has dramatically improved in Egypt. Between these two extremes, in Kenya the situation has improved for malnutrition and deteriorated for morbidity, whilst in Zimbabwe it has worsened for stunting and improved for underweight and diarrhea.

With reference to socioeconomic inequalities measured by concentration index and illustrated in Figures 6 to 8 with values multiplied by -100 for sake of convenience, almost all the estimates are in the expected direction (negative), indicating that poor health is more concentrated in the lower socioeconomic groups. Additionally, inequalities in malnutrition are higher than those in diarrhea in virtually all countries and time periods. Figure 6 shows that, as a general rule, higher levels of inequalities in child health are in Cameroon and in Egypt. At the other extreme, Kenya and Zimbabwe experience lower extent of socioeconomic inequalities. Furthermore, health inequalities have generally tended to narrow in Burkina Faso, and to a lesser degree in Cameroon, suggesting that factors responsible for the rising malnutrition and morbidity rates do not affect all socioeconomic groups in the same way. In contrast, inequalities among communities are on the rise in Egypt for stunting and diarrhea, and to a lesser extent in Kenya and Zimbabwe for underweight.

In Figure 7, the patterns of household wealth inequalities are virtually similar to those described above, with Cameroon witnessing the highest levels of inequalities for the three child health outcomes and the two periods, followed by Egypt, and the lowest values being recorded in Zimbabwe, Kenya and Burkina Faso, depending of the outcome. The trends over

time are also similar to those depicted for community socioeconomic inequalities. Finally, household social inequalities (Figure 8) are still highest in Cameroon, whilst the four other countries have roughly similar levels.

4.2. Clustering among communities in child health

The first objective of this study relates to whether childhood malnutrition and morbidity cluster among communities, and if the variation is accounted for by contextual factors over and above likely compositional effects. Estimates from Panel A in Table 1 (stunting), Table 2 (underweight) and Table 3 (diarrhea) show that community-level random variations are significantly different from zero at the level of 5% in all the countries and periods (Model 1), indicating apparent variability among communities in child health. Interestingly, family-level random variations are closer or equal to unity in all countries and periods, as expected with the hypothesis of binomial distribution of the outcome variables. Model 2 reveals that with the exception of underweight in Burkina Faso (Table 2, DHS-1), significant variations between communities remain after adjustment for familial- and child-level variables. It is therefore clear that differences among communities with regard to child malnutrition and morbidity cannot be explained simply by familial socioeconomic and demographic factors.

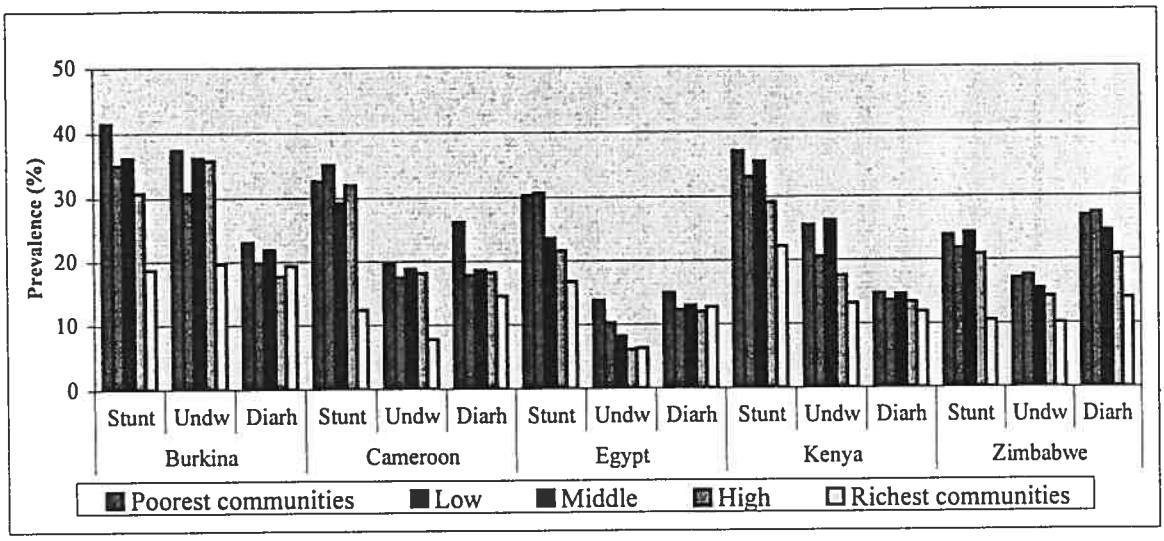


Figure 2. Community SES and malnutrition and morbidity among children (DHS-1)

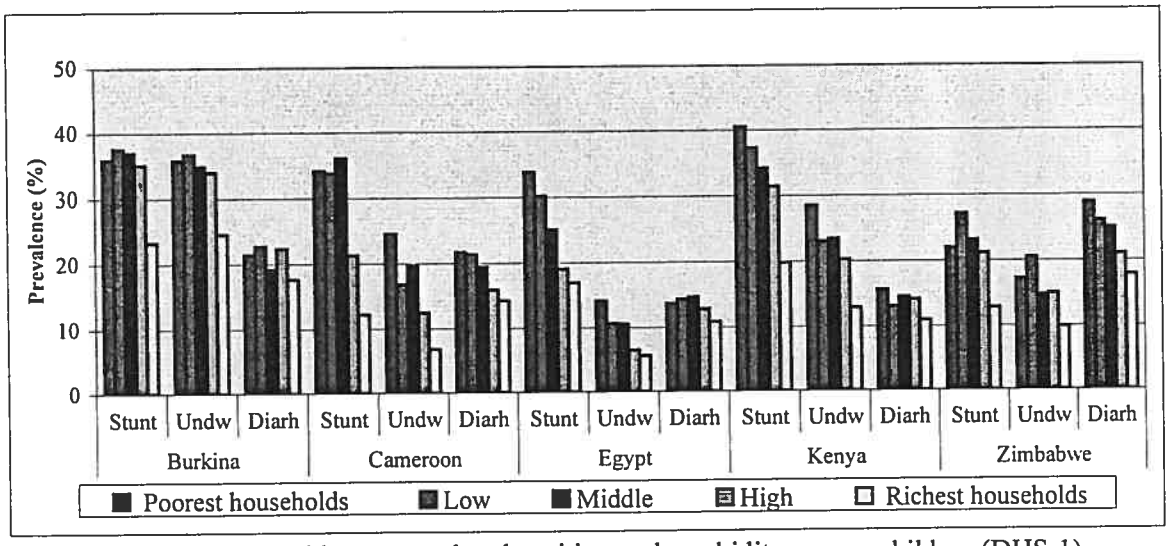


Figure 3. Household wealth status and malnutrition and morbidity among children (DHS-1)

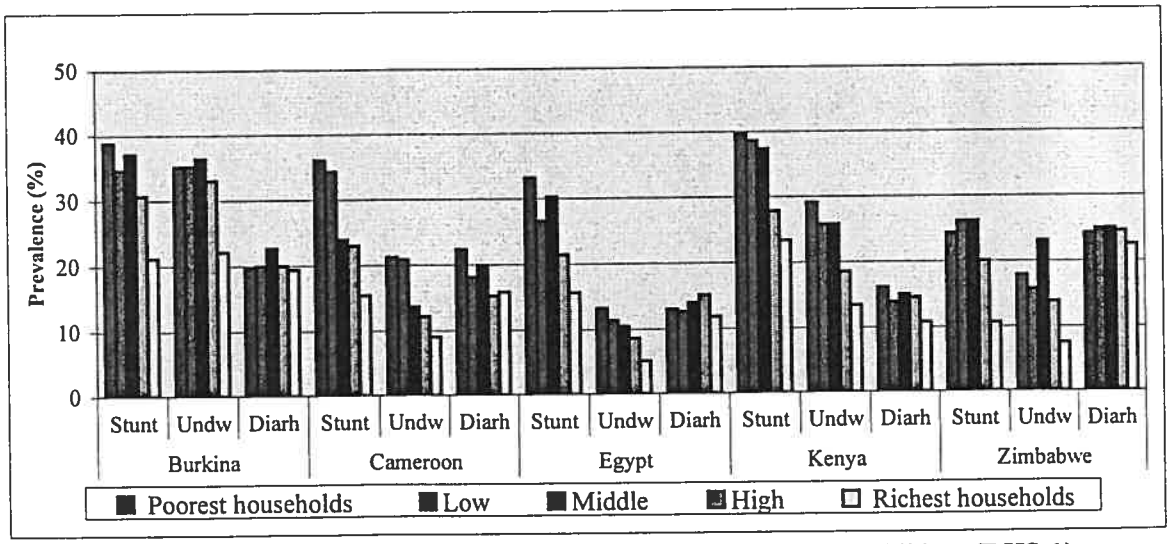


Figure 4. Household social status and malnutrition and morbidity among children (DHS-1)

Notes. Stunt: Stunting; Undw: Underweight; Diarh: Diarrhea morbidity

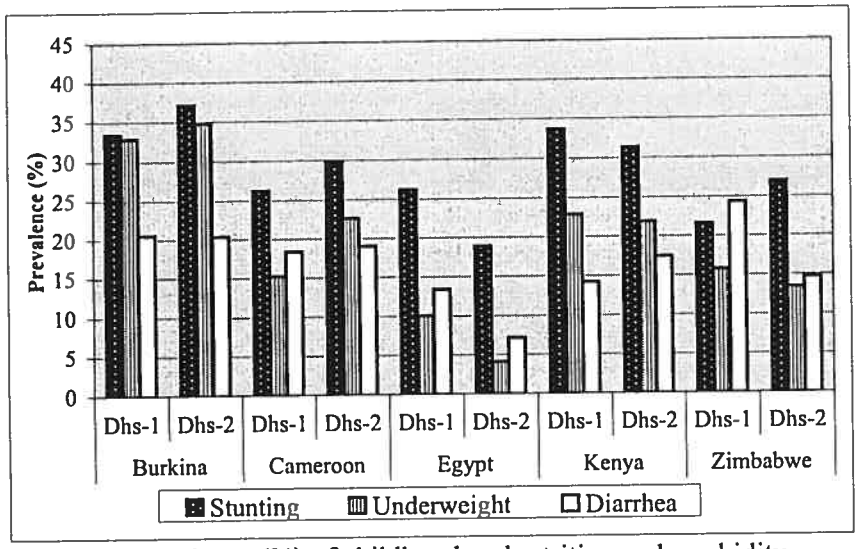


Figure 5. Prevalence (%) of childhood malnutrition and morbidity

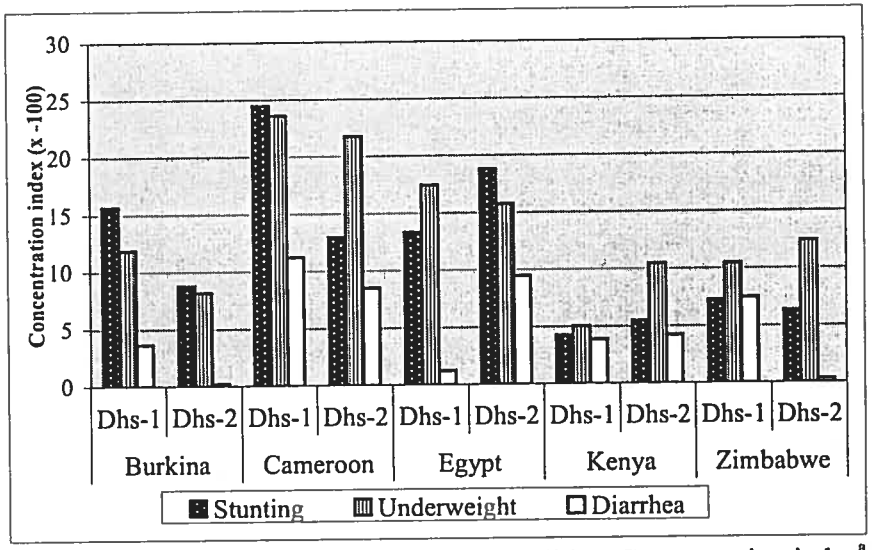


Figure 6. Community socioeconomic inequalities: Concentration index[a]

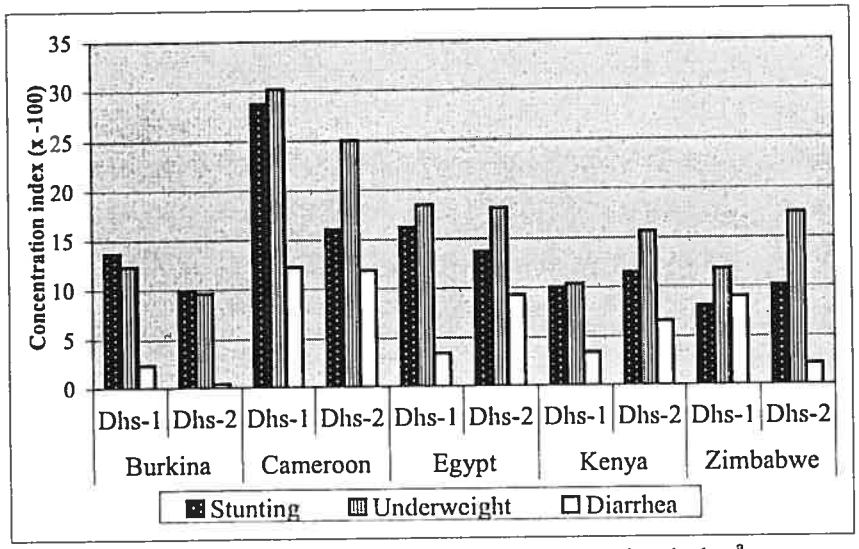


Figure 7. Household wealth inequalities: Concentration index[a]

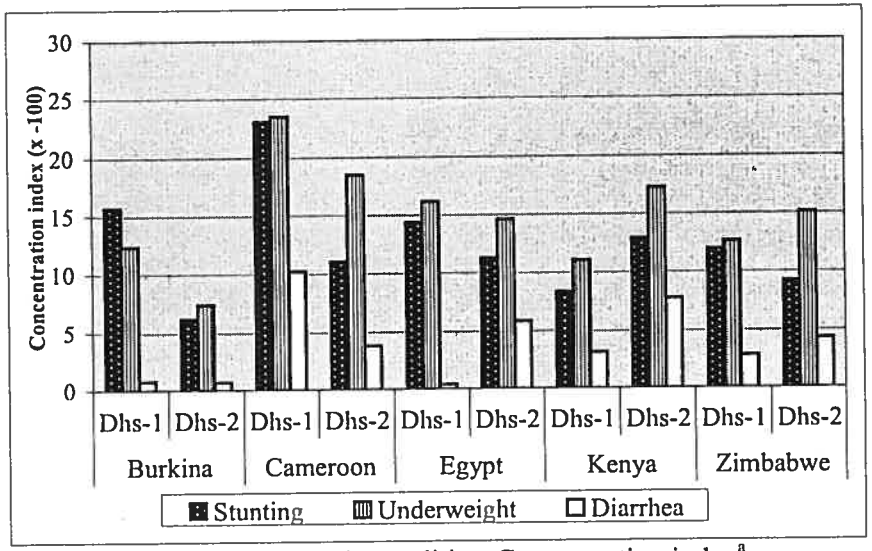


Figure 8. Household social inequalities: Concentration index[a]

[a]Concentration index for ill-health varying typically between 0 and -1, it has been multiplied by -100 in order to yield values between 0 and 100

4.3. Socioeconomic influences on child health

Our second hypothesis concerns the inverse relationship between SES and child health, with special interest in examining whether the SES of communities have independent contribution to child health, over and above the influences of the SES households. Model 3 in Tables 1 to 3 shows the "gross" socioeconomic effects without accounting for measured covariates, whilst Model 4 adjusts for household, mother and child characteristics. Model 4 in Tables 1 and 2 indicates that urban-rural differentials in childhood malnutrition are entirely explained by the SES of communities and families in virtually all countries. Figures for diarrhea morbidity reveal that whilst unadjusted rural rates of diarrhea are indistinguishable from urban ones except in Zimbabwe (results not shown), adjusted estimates in Models 3 and 4 (Table 3) suggest that urban children tend to be more likely than their counterparts in rural areas, to suffer from diarrhea, with statistically significant estimates in Cameroon and Kenya.

With reference to the socioeconomic effects on stunting (in the DHS-1), Model 3 (Table 1) shows that the three measures of SES are statistically significant in Burkina Faso; that household wealth and social indexes both exhibit significant effects in Egypt, Kenya and Zimbabwe; and that only wealth status emerges in Cameroon. Including controls (Model 4) results in a loss of statistical significance of the social status in Zimbabwe, and surprisingly, in a substantial increase between 20% and 50% of the estimates in Burkina Faso (community SES and wealth status) and Zimbabwe (wealth status). Comparing estimates in DHS-1 and DHS-2 (Model 4 in Table 1) reveals that with few exceptions socioeconomic inequalities have generally tended to narrow, with statistically significant changes in Burkina Faso for social inequalities ($p<0.01$) and in Zimbabwe for wealth inequalities ($p<0.10$).

Table 1. Multilevel estimates (coefficients) of the contextual and socioeconomic effects on childhood stunting

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	DHS-1	DHS-2	Change[a]	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change
Panel A: Variation (coefficients) among communities and families in childhood stunting															
Model 1: Without controls.															
σ^2_{u0}	0,130 ***	0,130 ***		0,484 ***	0,188 ***		0,201 ***	0,417 ***		0,199 ***	0,146 ***		0,173 ***	0,141 ***	
σ^2_{e0}	1,058	1,033		0,874	1,027		1,015	1,001		0,978	0,955		0,944	0,933	
Model 2: Controls for household wealth index, household social index, and other household, mother and child covariates[1].															
σ^2_{u0}	0,047 **	0,101 ***		0,290 ***	0,174 ***		0,116 ***	0,344 ***		0,153 ***	0,074 **		0,173 ***	0,075 ***	
σ^2_{e0}	1,024	1,021		0,907	1,017		0,996	0,986		0,966	0,969		0,853 **	0,942	
Panel B: Socioeconomic influences (coefficients) on childhood stunting															
Model 3: Without controls (Gross socioeconomic effects).															
Rural residence[b]	0,027	0,299	0,27	0,150	-0,049	-0,20	0,164	0,106	-0,06	-0,101	0,041	0,14	-0,356	-0,071	0,29
Community SES	-0,135 *	-0,037	0,10	-0,090	-0,064	0,03	-0,010	-0,156	-0,15	0,055	0,192	0,14	0,020	-0,083	-0,10
HH[c] wealth status	-0,205 ***	-0,323 ***	-0,12	-0,396 ***	-0,381 ***	0,02	-0,167 ***	-0,111 ***	0,06	-0,397 ***	-0,433 ***	-0,04	-0,356 ***	-0,154	0,20
HH social status	-0,221 ***	0,050	0,27 ***	-0,084	0,011	0,10	-0,181 ***	-0,066 *	0,12 *	-0,175 ***	-0,258 ***	-0,08	-0,189 ***	-0,122 **	0,07
Model 4: Expands Model 3 by adding household, mother and child covariates[1]															
Rural residence	-0,001	0,355	0,36	0,002	0,122	0,12	0,063	0,073	0,01	-0,002	-0,014	-0,01	-0,519	-0,039	0,48
Community SES	-0,162 *	-0,019	0,14	-0,093	0,032	0,13	-0,004	-0,170 *	-0,17	0,066	0,195	0,13	0,026	-0,074	-0,10
HH wealth status	-0,308 ***	-0,350 ***	-0,04	-0,429 ***	-0,351 ***	0,08	-0,164 ***	-0,089 **	0,08	-0,340 ***	-0,254 **	0,09	-0,471 ***	-0,111	0,36 *
HH social status	-0,235 ***	0,058	0,29 ***	-0,061	0,014	0,08	-0,131 ***	-0,068 *	0,06	-0,128 ***	-0,201 ***	-0,07	-0,069	-0,091	-0,02
Model 5: Includes cross level socioeconomic interactions to Model 4.															
Rural residence	-0,089	0,301		-0,205	0,156		0,029	-0,037		0,020	-0,145		-0,867 ***	-0,025	
Community SES	-0,194 ***	0,026		-0,239 **	0,090		-0,022	-0,253 **		0,068	0,107		-0,114	-0,072	
HH wealth status	-0,238 *	-0,396 **		-0,156	-0,312 ***		-0,168 ***	-0,128 ***		-0,343 ***	-0,342 ***		-0,464 ***	-0,114	
HH social status	-0,227 ***	0,040		-0,080	-0,001		-0,146 ***	-0,048		-0,118 **	-0,214 ***		-0,047	-0,077	
Com-Wealth interact[d]	-0,084	0,065		-0,315 ***	-0,054		0,003	-0,049 *		-0,003	0,143 **		-0,282 ***	-0,017	
Com-Social interact[e]	-0,029	-0,097 *		-0,030	-0,057		-0,042	0,029		0,023	-0,050		0,047	0,021	

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

σ^2_{u0} is the estimated coefficient for community-level random variation: statistical testing is about the hypothesis $\sigma^2_{u0} = 0$.

σ^2_{e0} is estimated coefficient for family-level random variation: statistical testing is about the hypothesis $\sigma^2_{e0} = 1$.

[a]Calculation of the standard deviation is based on the assumption of independence of the DHS-1 and DHS-2 samples in each country. This may not be the case strictly-speaking, since some households may be selected in both samples.

[b]Reference category: urban; [c]Household; [d]Community SES - Household wealth status interaction; [e]Community SES - Household social status interaction.

[1]At the household level: number of members, number of under-five children. At the mother level: religion, exposure to media, current age, teenage childbearing, nutritional status. At the child level: age, sex, low birth weight, antenatal care, place of delivery, immunization status, breast-feeding duration, and birth order/interval.

Table 2. Mu[illegible]vel estimates (coefficients) of the contextual and socioeconomic effects on childhood underweight

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbab[illegible]		
	DHS-1	DHS-2	Change[a]	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change
Panel A: Variation (coefficients) among communities and families in childhood underweight															
Model 1: Without controls.															
σ^2_{u0}	0,081 ***	0,141 ***		0,773 ***	0,466 ***		0,220 ***	0,415 ***		0,169 ***	0,213 ***		0,092 **	0,242 ***	
σ^2_{e0}	1,059	1,030		0,854	1,017		1,027	1,016		0,997	0,989		0,955	0,920	
Model 2: Controls for household wealth index, household social index, and other household, mother and child covariates[1].															
σ^2_{u0}	0,030	0,099 ***		0,392 ***	0,339 ***		0,144 ***	0,260 ***		0,105 ***	0,068 *		0,098 **	0,154 *	
σ^2_{e0}	1,014	0,999		0,911	1,003		0,993	0,988		0,977	0,902		0,869 **	0,906	
Panel B: Socioeconomic influences (coefficients) on childhood underweight															
Model 3: Without controls (Gross socioeconomic effects).															
Rural residence[b]	0,255 *	0,153	-0,10	0,148	-0,481	-0,63	-0,150	0,293	0,44	0,045	-0,019	-0,06	-0,372	0,256	0,63
Community SES	0,003	-0,073	-0,08	0,001	-0,372 **	-0,37 *	-0,187 **	0,016	0,20	0,022	-0,066	-0,09	0,037	0,014	-0,02
HH[c] wealth status	-0,202 ***	-0,275 ***	-0,07	-0,402 ***	-0,330 ***	0,07	-0,149 **	-0,206 ***	-0,06	-0,312 ***	-0,412 ***	-0,10	-0,422 ***	-0,312 **	0,11
HH social status	-0,156 ***	0,028	0,18 ***	-0,124	-0,119	0,01	-0,194 ***	-0,022	0,17 *	-0,207 ***	-0,321 ***	-0,11	-0,146 **	-0,184 ***	-0,04
Model 4: Expands Model 3 by adding household, mother and child covariates[1]															
Rural residence	0,219 *	0,074	-0,15	0,005	-0,157	-0,16	-0,258	0,176	0,43	0,180	-0,050	-0,23	-0,346	0,273	0,62
Community SES	0,022	-0,060	-0,08	0,033	-0,207	-0,24	-0,162 **	0,025	0,19	0,049	-0,116	-0,17	0,047	-0,013	-0,06
HH wealth status	-0,255 ***	-0,275 ***	-0,02	-0,357 **	-0,291 *	0,07	-0,201 **	-0,180 ***	0,02	-0,211 **	-0,166	0,05	-0,314 *	-0,210	0,10
HH social status	-0,176 ***	0,038	0,21 ***	-0,108	-0,162	-0,05	-0,164 ***	0,013	0,18 *	-0,146 ***	-0,243 ***	-0,10	-0,036	-0,168 ***	-0,13
Model 5: Includes cross level socioeconomic interactions to Model 4.															
Rural residence	0,106	0,023		-0,114	-0,176		-0,295	0,057		0,472	-0,127		-0,856 **	0,120	
Community SES	-0,017	-0,016		-0,054	-0,218		-0,184 **	-0,028		0,097	-0,178		-0,168	-0,055	
HH wealth status	-0,202 *	-0,318 ***		-0,270	-0,320 *		-0,238 ***	-0,184 **		-0,267 ***	-0,250 *		-0,314 **	-0,176	
HH social status	-0,162 ***	0,022		-0,099	-0,168 *		-0,141 **	-0,065		-0,057	-0,210 ***		-0,015	-0,311 ***	
Com-Wealth interact[d]	-0,032	0,057		-0,066	0,068		-0,065	0,000		0,019	0,132		-0,378 **	0,081	
Com-Social interact[e]	-0,084 **	-0,092 **		-0,097	-0,048		0,052	-0,136 **		0,212 ***	0,041		0,035	-0,199 **	

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

σ^2_{u0} is the estimated coefficient for community-level random variation: statistical testing is about the hypothesis $\sigma^2_{u0} = 0$.

σ^2_{e0} is estimated coefficient for family-level random variation: statistical testing is about the hypothesis $\sigma^2_{e0} = 1$.

[a]Calculation of the standard deviation is based on the assumption of independence of the DHS-1 and DHS-2 samples in each country. This may not be the case strictly-speaking, since some households may be selected in both samples.

[b]Reference category: urban; [c]Household; [d]Community SES - Household wealth status interaction; [e]Community SES - Household social status interaction.

[1]At the household level: number of members, number of under-five children. At the mother level: religion, exposure to media, current age, teenage childbearing, nutritional status. At the child level: age, sex, low birth weight, antenatal care, place of delivery, immunization status, breast-feeding duration, and birth order/interval.

Table 3. Mu[illegible]el estimates (coefficients) of the contextual and socioeconomic effects on childhood diarrhea morbidity

	Burkina Faso			Cameroon			Egypt			Kenya			Zimba[illegible]		
	DHS-1	DHS-2	Change[a]	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change	DHS-1	DHS-2	Change
Panel A: Variation (coefficients) among communities and families in childhood diarrhea morbidity															
Model 1: Without controls.															
σ^2_{u0}	0,088 **	0,114 ***		0,393 ***	0,234 ***		0,230 ***	0,272 ***		0,196 ***	0,119 ***		0,091 **	0,141 ***	
σ^2_{e0}	1,064	1,011		0,947	0,992		0,971	0,965		1,016	0,980		0,964	0,964	
Model 2: Controls for household wealth index, household social index, and other household, mother and child covariates[1].															
σ^2_{u0}	0,091 ***	0,132 ***		0,308 ***	0,179 ***		0,246 ***	0,250 ***		0,182 ***	0,111 ***		0,060 *	0,171 ***	
σ^2_{e0}	1,057	1,007		0,975	1,011		0,970	0,951		1,009	0,986		0,974	0,957	
Panel B: Socioeconomic influences (coefficients) on childhood diarrhea morbidity															
Model 3: Without controls (Gross socioeconomic effects).															
Rural residence[b]	-0,243	0,255	0,50	-0,505 **	-0,354	0,15	-0,231	0,043	0,27	-0,596 *	-0,593 *	0,00	-0,023	-0,041	-0,02
Community SES	-0,117 *	0,044	0,16	-0,259 **	-0,148	0,11	-0,077	-0,070	0,01	-0,096	-0,060	0,04	-0,131	-0,088	0,04
HH[c] wealth status	-0,090 *	-0,020	0,07	-0,205 ***	-0,329 ***	-0,12	-0,120 *	-0,064 *	0,06	-0,210 ***	-0,309 ***	-0,10	-0,245 **	-0,082	0,16
HH social status	-0,007	0,059	0,07	-0,048	0,128	0,18	0,020	0,011	-0,01	-0,121 **	-0,111 **	0,01	0,142 **	-0,016	-0,16 *
Model 4: Expands Model 3 by adding household, mother and child covariates[1]															
Rural residence	-0,261	0,174	0,44	-0,489 *	-0,272	0,22	-0,232	0,011	0,24	-0,519 *	-0,510	0,01	0,036	-0,118	-0,15
Community SES	-0,096	0,061	0,16	-0,242 **	-0,076	0,17	-0,069	-0,113	-0,04	-0,090	-0,050	0,04	-0,143	-0,063	0,08
HH wealth status	-0,079 *	-0,064	0,02	-0,193 ***	-0,406 ***	-0,21	-0,053	-0,147 ***	-0,09	-0,244 ***	-0,261 **	-0,02	-0,160	-0,180	-0,02
HH social status	-0,007	0,079	0,09	-0,060	0,122	0,18	-0,046	-0,053	-0,01	-0,126 **	-0,057	0,07	0,194 **	-0,026	-0,22 **
Model 5: Includes cross level socioeconomic interactions to Model 4.															
Rural residence	-0,225	0,226		-0,617 **	-0,397		-0,366	-0,132		-0,581 *	-0,424		-0,069	-0,237	
Community SES	-0,091	0,088		-0,341 **	-0,211		-0,136	-0,180		-0,122	0,024		-0,185	-0,040	
HH wealth status	-0,049	-0,039		-0,072	-0,534 ***		-0,094	-0,168 ***		-0,163 **	-0,179 *		-0,156	-0,207 *	
HH social status	-0,015	0,078		-0,054	0,147		-0,075	-0,099 **		-0,097 **	-0,096		0,201 **	-0,094	
Com-Wealth interact[d]	-0,044	-0,017		-0,090	0,149 *		-0,044	-0,022		-0,208 ***	-0,117		-0,080	-0,276 ***	
Com-Social interact[e]	0,053	0,001		-0,097	0,094		-0,086	-0,082 *		0,102	-0,065		0,017	-0,100	

*p < 0.10; **p < 0.05; ***p < 0.01.

σ^2_{u0} is the estimated coefficient for community-level random variation: statistical testing is about the hypothesis $\sigma^2_{u0} = 0$.

σ^2_{e0} is estimated coefficient for family-level random variation: statistical testing is about the hypothesis $\sigma^2_{e0} = 1$.

[a]Calculation of the standard deviation is based on the assumption of independence of the DHS-1 and DHS-2 samples in each country. This may not be the case strictly-speaking, since some households may be selected in both samples.

[b]Reference category: urban; [c]Household; [d]Community SES - Household wealth status interaction; [e]Community SES - Household social status interaction.

[1]At the household level: number of members, number of under-five children. At the mother level: religion, exposure to media, current age, teenage childbearing, nutritional status. At the child level: age, sex, low birth weight, antenatal care, place of delivery, immunization status, breast-feeding duration, and birth order/interval.

Table 4. Socio-economic influences (coefficients) on the co-occurrence stunting-diarrhea[a] among children

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	One[b] vs None[c] (1)	Both[d] vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)
DHS-1															
Model 1: No controls (Gross effects)															
Rural residence[e]	-0,033	-0,021	-0,012	-0,283 *	-0,589 *	0,307	0,100	-0,262	0,362 *	-0,430 **	0,151	-0,581	-0,234	-0,512	0,278
Community SES	-0,123 ***	-0,194 ***	0,071	-0,166 **	-0,190	0,023	0,040	-0,160 *	0,201 **	-0,066	0,138	-0,204	-0,140	0,012	-0,152
HH[f] wealth status	-0,132 **	-0,259 **	0,127	-0,310 ***	-0,697 ***	0,387 **	-0,183 ***	-0,285 ***	0,101	-0,407 ***	-0,465 ***	0,058	-0,294 ***	-0,577 ***	0,284
HH social status	-0,156 ***	-0,174 *	0,018	-0,069	-0,225 *	0,156	-0,122 ***	-0,051	-0,071	-0,114 ***	-0,278 ***	0,163 **	0,034	-0,188 *	0,222 *
Model 2: Controls for household, mother and child covariates[1] (Net effects)															
Rural residence	-0,050	0,002	-0,053	-0,359 **	-0,736 **	0,378	0,019	-0,404 *	0,423 **	-0,382 **	0,315	-0,697 *	-0,202	-0,689	0,487
Community SES	-0,160 ***	-0,158 **	-0,001	-0,186 **	-0,142	-0,044	0,031	-0,144	0,175 *	-0,068	0,127	-0,195	-0,142	0,056	-0,198
HH wealth status	-0,186 ***	-0,245 *	0,060	-0,249 ***	-0,818 ***	0,569 ***	-0,173 ***	-0,246 **	0,073	-0,366 ***	-0,381 **	0,015	-0,248 **	-0,740 ***	0,492 *
HH social status	-0,179 ***	-0,161	-0,018	-0,010	-0,227 *	0,217	-0,110 ***	-0,038	-0,072	-0,085 **	-0,219 ***	0,135 *	0,163 **	-0,104	0,267 **
DHS-2															
Model 1: No controls (Gross effects)															
Rural residence	0,340	0,214	0,126	-0,342	-0,482	0,140	0,011	-0,172	0,183	0,133	-1,162 ***	1,295 ***	-0,019	-0,405	0,386
Community SES	-0,012	0,037	-0,050	-0,109	-0,225	0,115	-0,215 ***	-0,403 ***	0,188 ***	0,200	-0,370	0,570 **	-0,081	-0,172	0,091
HH wealth status	-0,112 **	-0,414 ***	0,303 **	-0,330 ***	-0,831 ***	0,501 ***	-0,171 ***	-0,160 *	-0,011	-0,388 ***	-0,605 ***	0,217	-0,127	-0,194	0,068
HH social status	0,014	0,026	-0,012	0,040	0,210 *	-0,170	-0,012	-0,135	0,123	-0,243 ***	-0,249 ***	0,006	-0,133 **	-0,076	-0,057
Model 2: Controls for household, mother and child covariates[1] (Net effects)															
Rural residence	0,363	0,135	0,228	-0,192	-0,270	0,078	-0,011	-0,316	0,304	0,150	-1,207 ***	1,357 ***	-0,098	-0,387	0,289
Community SES	-0,016	0,130	-0,146	-0,020	-0,089	0,069	-0,220 ***	-0,497 ***	0,277 ***	0,234 *	-0,370	0,604 **	-0,130	-0,130	0,001
HH wealth status	-0,135 **	-0,576 ***	0,441 **	-0,284 ***	-0,896 ***	0,612 ***	-0,155 ***	-0,271 **	0,116	-0,275 ***	-0,326 *	0,051	-0,134	-0,211	0,076
HH social status	0,002	0,083	-0,081	0,062	0,238 *	-0,176	-0,025	-0,151	0,126	-0,181 ***	-0,145	-0,036	-0,127 **	-0,009	-0,118

[a]The variable has three categories: 0 (neither stunting nor diarrhea), 1 (stunting or diarrhea), and 2 (both stunting and diarrhea); with zero as the reference category.

[b]One: Stunting or diarrhea; [c]None: Neither stunting nor Diarrhea; [d]Both: Stunting and Diarrhea; [e]Reference category: urban; [f]Household.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

[1]At the household level: number of members, number of under-five children. At the mother level: religion, exposure to media, current age, teenage childbearing, nutritional status. At the child level: age, sex, low birth weight, antenatal care, place of delivery, immunization status, breast-feeding duration, and birth order/interval.

Note: Models 1 and 2 correspond respectively to Models 3 and 4 in Tables 1 to 3.

Table 5. Socio-economic influences (coefficients) on the co-occurrence underweight-diarrhea[a] among children

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	One[b] vs None[c] (1)	Both[d] vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)	One vs None (1)	Both vs None (2)	One vs Both (3) (1)-(2)
DHS-1															
Model 1: No controls (Gross effects)															
Rural residence[e]	0,163	0,066	0,097	-0,452 ***	-0,934 ***	0,482	-0,338 ***	-0,262	-0,075	-0,295	0,203	-0,498	-0,460 *	0,210	-0,670
Community SES	-0,055	-0,059	0,004	-0,134 *	-0,163	0,029	-0,177 ***	-0,176	-0,002	-0,070	0,112	-0,182	-0,186	0,098	-0,284
HH[f] wealth status	-0,090 *	-0,338 ***	0,248 **	-0,194 ***	-0,994 ***	0,800 ***	-0,104 **	-0,368 ***	0,265 **	-0,279 ***	-0,469 ***	0,191	-0,292 ***	-0,596 ***	0,303
HH social status	-0,085	-0,148	0,063	-0,106	-0,195	0,089	-0,058	-0,025	-0,033	-0,148 ***	-0,300 ***	0,151 *	0,049	-0,059	0,108
Model 2: Controls for household, mother and child covariates[1] (Net effects)															
Rural residence	0,134	0,063	0,071	-0,380 **	-1,057 ***	0,677 *	-0,405 ***	-0,356	-0,048	-0,225	0,389	-0,614	-0,361	0,214	-0,574
Community SES	-0,070	-0,011	-0,059	-0,090	-0,118	0,028	-0,177 ***	-0,143	-0,034	-0,056	0,140	-0,196	-0,185	0,140	-0,325
HH wealth status	-0,127 **	-0,294 **	0,167	-0,079	-0,986 ***	0,907 ***	-0,115 **	-0,289 *	0,174	-0,221 ***	-0,380 **	0,159	-0,206 *	-0,502 *	0,295
HH social status	-0,113 **	-0,154	0,041	-0,058	-0,110	0,053	-0,090 **	-0,043	-0,047	-0,104 ***	-0,258 ***	0,154 *	0,149 **	0,056	0,094
DHS-2															
Model 1: No controls (Gross effects)															
Rural residence	0,107	0,190	-0,083	-0,557 **	-1,057 **	0,499	-0,058	0,784	-0,842 *	-0,154	-1,445 ***	1,292 **	0,071	-0,176	0,247
Community SES	-0,076	0,031	-0,108	-0,170	-0,749 ***	0,579 **	-0,114 ***	-0,232 **	0,118	0,029	-0,865 **	0,894 **	-0,020	-0,186	0,167
HH wealth status	-0,091	-0,295 **	0,204	-0,403 ***	-0,637 ***	0,234	-0,177 ***	-0,228	0,051	-0,321 ***	-0,886 ***	0,564 **	-0,176 *	-0,236	0,060
HH social status	-0,022	0,011	-0,033	0,051	0,054	-0,002	0,008	-0,104	0,112	-0,240 ***	-0,288 ***	0,048	-0,086	-0,244 *	0,158
Model 2: Controls for household, mother and child covariates[1] (Net effects)															
Rural residence	0,049	0,095	-0,046	-0,322	-0,763	0,441	-0,100	0,598	-0,698	-0,149	-1,408 **	1,259 **	-0,003	-0,290	0,287
Community SES	-0,053	0,084	-0,137	-0,039	-0,575 **	0,536 *	-0,133 ***	-0,296 **	0,163	0,046	-0,898 **	0,944 **	-0,056	-0,284	0,228
HH wealth status	-0,126 **	-0,351 **	0,224	-0,329 ***	-0,682 ***	0,353	-0,188 ***	-0,350 *	0,162	-0,191 **	-0,461	0,270	-0,209 *	-0,127	-0,082
HH social status	-0,007	0,035	-0,042	0,077	0,029	0,048	-0,007	-0,193	0,186	-0,163 ***	-0,183	0,019	-0,066	-0,276 *	0,209

[a]The variable has three categories: 0 (neither underweight nor diarrhea), 1 (underweight or diarrhea), and 2 (both underweight and diarrhea); with zero as the reference category.

[b]One: Underweight or diarrhea; [c]None: Neither Underweight nor Diarrhea; [d]Both: Underweight and Diarrhea; [e]Reference category: urban; [f]Household.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

[1]At the household level: number of members, number of under-five children. At the mother level: religion, exposure to media, current age, teenage childbearing, nutritional status. At the child level: age, sex, low birth weight, antenatal care, place of delivery, immunization status, breast-feeding duration, and birth order/interval.

Note: Models 1 and 2 correspond respectively to Models 3 and 4 in Tables 1 to 3.

As concerns underweight (Table 2), Model 3 shows that the three SES indexes are statistically significant in Egypt; that household wealth and social indexes have significant effects in Burkina Faso, Kenya and Zimbabwe with larger magnitude for wealth status; and that only wealth status reaches statistical significance in Cameroon. Model 4 produces no significant change, except in Zimbabwe where social index loses statistical significance. Additionally, it reveals that socioeconomic inequalities with regard to underweight have generally tended to widen in Cameroon and Kenya for community SES and household social status, as well as in Zimbabwe for household social status, without however reaching statistical significance. By contrast, significant reduction in socioeconomic inequalities is recorded in Burkina Faso and Egypt for social index ($p<0.01$ and $p<0.10$, respectively).

Finally, Model 4 in Table 3 shows that community SES and household wealth status are significantly associated with diarrhea morbidity in Cameroon; that household wealth and social indexes emerge in Kenya; and that only the wealth status is significant in Burkina Faso. In Egypt in contrast, no measurable SES has influence on diarrhea morbidity, whilst in Zimbabwe, household social status is positively associated with diarrhea occurrence ($p<0.05$). Model 4 further reveals that without reaching statistical significance, socioeconomic inequalities in morbidity among communities have tended to diminish in Cameroon, and that inequalities among families have been on the rise in Cameroon and Egypt.

4.4. Co-occurrence of malnutrition and diarrhea morbidity

Our interest in this study includes the evaluation of the socioeconomic influences on the co-occurrence of malnutrition and diarrhea morbidity. With regard to stunting-diarrhea (Table 4), gross estimates (Model 1) in columns 1 and 2 are generally in line with expectation, as the odds of suffering from either stunting or diarrhea (Column 1), and the odds of suffering from both stunting and diarrhea (Column 2) decrease with increasing SES. Interestingly, estimates

in Column 2 are generally larger than those in Column 1 especially when their difference (Column 3) reaches statistical significance, suggesting that living in poorest socioeconomic conditions (household or community) increases the odds of suffering from both stunting and diarrhea, as opposed to experiencing only one of the two outcomes. As a matter of illustration, converting[12] the coefficient for Cameron (DHS-1) into odds ratio indicates that in the poorest 30% households, as opposed to the richest 30% ones, children are almost 2.3 times more likely to suffer from both stunting and diarrhea morbidity as opposed to suffering from only one of the two pathologies. Overall, statistically significant estimates in Column 3 are recorded for community SES in Egypt ($p<0.05$), for wealth status in Cameroon ($p<0.05$), and for social status in Kenya and Zimbabwe ($p<0.05$ and $p<0.10$ respectively).

Adding controls in Model 2 does not significantly alter these patterns, except in Zimbabwe where coefficient for wealth status is now statistical significant. It is worth noting that larger estimates in Column 3 are recorded in Cameroon and to a lesser degree in Zimbabwe. On the other hand, some changes from DHS-1 to DHS-2 in coefficients estimated in Column 3 (Model 2) can be observed in Burkina Faso where wealth status is now statistically significant; in Cameroon and Egypt where wealth status and community SES respectively have larger effects; in Kenya where community SES reaches statistical significance at the expense of the social status; and in Zimbabwe where no socioeconomic effect is significant.

For underweight-diarrhea, similar findings emerge from Table 5, as results in Model 1 (DHS-1) generally display positive estimates in Column 3 for the three socioeconomic measures. Including controls (Model 2) tends to reduce the size and the degree of significance of estimates (Column 3), in Burkina Faso, Egypt and Zimbabwe. Finally, noticeable changes from DHS-1 to DHS-2 (Model 2) are in Cameroon, with a substantial reduction of the wealth

[12] This is done using mean values of the socioeconomic indexes.

effects; and in Kenya where community SES is now statistically significant at the expense of social status.

4.5. Modification of the household socioeconomic effects by the community SES

Besides investigating socioeconomic influences on child health, it is particularly relevant to examine whether the SES of communities exacerbates or mitigates the effects of the household SES on child health. Though Model 5 in Tables 1 to 3 displays cross-level interactive effects, which allow us to have an overview of the interplay between household and community SES, it is more compelling to examine whether higher community SES *initiates/enlarges,* or *lessens/eliminates* the effects of familial SES on health. Conditional household socioeconomic effects are outlined in Tables 6 and 7 according to five community socioeconomic quintile groups.

With regard to household wealth effects (Table 6), Figures for the DHS-1 are mainly consistent with *initiating/enlarging* model, as the estimates generally increase with increasing community SES, indicating that the wealth situation of families affects child health mainly in the more privileged areas. In Cameroon for example, there is a very strong wealth effects on stunting in the fourth and richest communities ($p<0.01$), though the interaction term (average effect) failed to reach statistical significance. These patterns of household wealth status having almost no impact on child health in the most deprived communities and significant effects in the most affluent ones, are also noticeable in Burkina Faso for the three health outcomes, in Zimbabwe for malnutrition and in Kenya for diarrhea morbidity. From the DHS-1 to the DHS-2, a shift from *initiating/enlarging* to *lessening/eliminating* model is recorded in Burkina Faso for malnutrition and in Cameroon for underweight and diarrhea, whilst an opposite change is recorded in Egypt for stunting.

Table 6. Main, average and conditional effects (coefficients) of the household wealth status on childhood malnutrition and morbidity

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	Stunt[a]	Undw[b]	Diarh[c]	Stunt	Undw	Diarh	Stunt	Undw	Diarh	Stunt	Undw	Diarh	Stunt	Undw	Diarh
In the DHS-1:															
Main effects[d]	-0,308 ***	-0,255 ***	-0,079 *	-0,429 ***	-0,357 **	-0,193 ***	-0,164 ***	-0,201 **	-0,053	-0,340 ***	-0,211 **	-0,244 ***	-0,471 ***	-0,314 *	-0,160
Average effects[e]	-0,238 *	-0,202 *	-0,049	-0,156	-0,270	-0,072	-0,168 ***	-0,238 ***	-0,094	-0,343 ***	-0,267 ***	-0,163 **	-0,464 ***	-0,314 **	-0,156
Conditional effects[f]:															
Poorest communities	-0,112	-0,154	0,017	0,294	-0,176	0,056	-0,173 **	-0,131	-0,022	-0,339 ***	-0,290 *	0,091	-0,082	0,198	-0,048
Low	-0,196	-0,186	-0,027	0,002	-0,237	-0,027	-0,169 ***	-0,215 **	-0,078	-0,341 ***	-0,279 **	-0,031	-0,260 *	-0,041	-0,098
Middle	-0,243 *	-0,204 *	-0,052	-0,159	-0,271	-0,073	-0,167 **	-0,262 ***	-0,110	-0,342 ***	-0,272 ***	-0,109	-0,465 ***	-0,315 **	-0,156
High	-0,287 ***	-0,221 ***	-0,075	-0,338 ***	-0,308 *	-0,124	-0,166 *	-0,289 ***	-0,129	-0,345 ***	-0,256 ***	-0,287 ***	-0,738 ***	-0,681 ***	-0,234
Richest communities	-0,351 ***	-0,245 ***	-0,108 **	-0,596 ***	-0,362 *	-0,198 ***	-0,165 *	-0,296 ***	-0,133	-0,348 ***	-0,238 *	-0,476 ***	-0,785 ***	-0,744 ***	-0,247
In the DHS-2:															
Main effects[d]	-0,350 ***	-0,275 ***	-0,064	-0,351 ***	-0,291 *	-0,406 ***	-0,089 **	-0,180 ***	-0,147 ***	-0,254 **	-0,166	-0,261 **	-0,111	-0,210	-0,180
Average effects[e]	-0,396 **	-0,318 ***	-0,039	-0,312 ***	-0,320 *	-0,534 ***	-0,128 ***	-0,184 **	-0,168 ***	-0,342 ***	-0,250 *	-0,179 *	-0,114	-0,176	-0,207 *
Conditional effects[f]:															
Poorest communities	-0,431 **	-0,349 **	-0,030	-0,263 *	-0,382 *	-0,670 ***	-0,055	-0,184 ***	-0,135 **	-0,470 ***	-0,368 **	-0,074	-0,094	-0,272	0,120
Low	-0,431 **	-0,349 **	-0,030	-0,271 **	-0,371 *	-0,646 ***	-0,107 **	-0,184 ***	-0,159 ***	-0,448 ***	-0,348 **	-0,092	-0,098	-0,254	0,059
Middle	-0,429 **	-0,347 **	-0,030	-0,294 ***	-0,343 *	-0,584 ***	-0,138 ***	-0,184 **	-0,172 ***	-0,397 ***	-0,301 **	-0,134	-0,117	-0,163	-0,252 **
High	-0,408 **	-0,328 **	-0,036	-0,333 ***	-0,293 *	-0,476 ***	-0,161 ***	-0,184 **	-0,183 ***	-0,281 **	-0,194	-0,229 **	-0,126	-0,117	-0,410 ***
Richest communities	-0,275 ***	-0,212 ***	-0,071	-0,404 ***	-0,205	-0,281 **	-0,178 ***	-0,184 *	-0,191 **	-0,106	-0,032	-0,372 **	-0,136	-0,070	-0,567 ***

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

[a]Stunting; [b]Underweight; [c]Diarrhea morbidity; [d]From Model 4 in Tables 1, 2, and 3; [e]From Model 5 in Tables 1, 2, and 3.

[f]If β_1, β_2 and β_3 are the coefficients for X_1, X_2 and $X_1.X_2$ respectively, then conditionally on a value x_2 of X_2, the effect of X_1 noted β'_1 and its standard error $\sigma(\beta'_1)$ are:

$$\beta_1' = \beta_1 + x_2.\beta_3 \; ; \quad \sigma(\beta_1') = \sqrt{\mathrm{Var}(\beta_1) + x_2^2.\mathrm{Var}(\beta_3) + 2.x_2.\mathrm{Cov}(\beta_1, \beta_3)}$$

Table 7. Main, average and conditional effects (coefficients) of the household social status on childhood malnutrition and morbidity

	Burkina Faso			Cameroon			Egypt			Kenya			Zimbabwe		
	Stunt[a]	Undw[b]	Diarh[c]	Stunt	Undw	Diarh	Stunt	Undw	Diarh	Stunt	Undw	Diarh	Stunt	Undw	Diarh
In the DHS-1:															
Main effects[d]	-0,235 ***	-0,176 ***	-0,007	-0,061	-0,108	-0,060	-0,131 ***	-0,164 ***	-0,046	-0,128 ***	-0,146 ***	-0,126 **	-0,069	-0,036	0,194 **
Average effects[e]	-0,227 ***	-0,162 ***	-0,015	-0,080	-0,099	-0,054	-0,146 ***	-0,141 **	-0,075	-0,118 **	-0,057	-0,097 **	-0,047	-0,015	0,201 **
Conditional effects[f]:															
Poorest communities	-0,183	-0,036	-0,095	-0,037	0,039	0,084	-0,077	-0,226 *	0,066	-0,146 *	-0,315 ***	-0,221 *	-0,111	-0,062	0,178 *
Low	-0,213 **	-0,120 *	-0,041	-0,065	-0,050	-0,005	-0,131 ***	-0,159 ***	-0,045	-0,133 ***	-0,192 ***	-0,162 **	-0,081	-0,040	0,189 **
Middle	-0,229 ***	-0,167 ***	-0,012	-0,080	-0,100	-0,055	-0,161 ***	-0,122 *	-0,106 **	-0,124 ***	-0,112 **	-0,123 **	-0,047	-0,015	0,201 **
High	-0,244 ***	-0,211 ***	0,016	-0,097	-0,155	-0,110	-0,179 ***	-0,100	-0,142 **	-0,104	0,070	-0,036	-0,001	0,019	0,218
Richest communities	-0,266 ***	-0,275 ***	0,057	-0,122	-0,234	-0,189	-0,183 ***	-0,095	-0,151 **	-0,083	0,262 *	0,057	0,007	0,025	0,220
In the DHS-2:															
Main effects[d]	0,058	0,038	0,079	0,014	-0,162	0,122	-0,068 *	0,013	-0,053	-0,201 ***	-0,243 ***	-0,057	-0,091	-0,168 ***	-0,026
Average effects[e]	0,040	0,022	0,078	-0,001	-0,168 *	0,147	-0,048	-0,065	-0,099 **	-0,214 ***	-0,210 ***	-0,096	-0,077	-0,311 ***	-0,094
Conditional effects[f]:															
Poorest communities	0,092	0,072	0,077	0,051	-0,124	0,061	-0,091 **	0,139	0,024	-0,169 ***	-0,247 ***	-0,038	-0,102	-0,075	0,024
Low	0,092	0,072	0,077	0,042	-0,132	0,076	-0,060	-0,008	-0,064	-0,177 ***	-0,241 ***	-0,048	-0,097	-0,119 *	0,002
Middle	0,090	0,069	0,077	0,018	-0,152	0,115	-0,042	-0,092	-0,115 **	-0,195 ***	-0,226 ***	-0,071	-0,074	-0,344 ***	-0,110
High	0,058	0,039	0,078	-0,023	-0,187 *	0,184 *	-0,029	-0,156 *	-0,154 ***	-0,235 **	-0,192 **	-0,124	-0,062	-0,457 ***	-0,167
Richest communities	-0,140	-0,149 **	0,080	-0,098	-0,249	0,306 *	-0,018	-0,204 **	-0,183 **	-0,297	-0,142	-0,203	-0,050	-0,571 ***	-0,225

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

[a]Stunting; [b]Underweight; [c]Diarrhea morbidity; [d]From Model 4 in Tables 1, 2, and 3; [e]From Model 5 in Tables 1, 2, and 3.

[f]If β_1, β_2 and β_3 are the coefficients for X_1, X_2 and $X_1.X_2$ respectively, then conditionally on a value x_2 of X_2, the effect of X_1 noted β'_1 and its standard error $\sigma(\beta'_1)$ are:

$$\beta_1^{'} = \beta_1 + x_2.\beta_3 \; ; \quad \sigma(\beta_1^{'}) = \sqrt{\mathrm{Var}(\beta_1) + x_2^2.\mathrm{Var}(\beta_3) + 2.x_2.\mathrm{Cov}(\beta_1, \beta_3)}$$

As regards household social effects, Table 7 reveals a somewhat contrasting picture with the coexistence of *initiating/enlarging* and *lessening/eliminating* models across and within countries, though the former emerges more frequently. The latter is recorded for in Kenya (for the three outcomes) and in Egypt (for underweight), as household social status is estimated to have no influence on child health among families living in relatively more privileged communities. There is an atypical pattern in Zimbabwe with positive and significant coefficients for diarrhea. On the other hand, very few changes between DHS-1 and DHS-2 in the patterns of interaction can be observed.

5. Summary and discussion

This paper has examined the issues of clustering of, and socioeconomic inequalities in, childhood malnutrition and morbidity among communities and families in Africa. Its novelty is to define and use more standardized measures of the SES within a multilevel framework, to model the co-occurrence of malnutrition and morbidity, and to demonstrate the ways in which interaction between family and community characteristics on child health can be comprehensively considered in the case of continuous measures. In fact, although many studies have modelled interaction terms, there has been relatively little use of cross-level ones, and few papers have attempted to probe how the presence of an interaction term alters the interpretation of other coefficients, especially in the case of continuous predictors. A number of key findings emerge from this study:

First, variations in child health among communities are clearly accounted for by contextual factors over and above likely compositional effects, even though differences between communities in the risks of childhood malnutrition and morbidity are found to originate mainly from differences in familial characteristics. Such finding which is in line with most studies that have attempted to disentangle contextual from compositional effects (Madise et al., 1999; Subramanian et al., 2003; Frohlich et al., 2002), upholds a key role for community

context as a strong influence on health. Thus, it supports the growing body of research suggesting that neighborhood characteristics per se exert an important influence on the resident's health (Macintyre et al., 1993; Pickett and Pearl, 2001).

Second, there is a strong patterning in child nutritional status along SES lines, with household wealth status emerging to be the most powerful predictor as its effects outweigh in virtually all countries and time periods the influences of the two other socioeconomic indexes, and community SES having in some instances a contribution independent of the effect of the SES of households. This latter finding reinforces the relevance of neighborhood characteristics in health research (Robert, 1999; Mosley and Chen, 1984; Cortinovis et al., 1993). On the other hand, unlike most other studies (Adair and Guilkey, 1997; Forste, 1998; Tharakan and Suchindran, 1999), our results clearly show that urban-rural differentials in childhood malnutrition are entirely accounted for by the SES of communities and families. This probably relates to a stronger explanatory power of our standardized socioeconomic measures. Moreover, our results provide evidence of co-occurrence between malnutrition and infection and suggest that living in poorest socioeconomic conditions (household or community) increases the odds of suffering from both malnutrition and diarrhea, as opposed to experiencing only one of the two outcomes. A number of studies have produced evidence of nutritional risk factor for diarrhea (Etiler et al., 2004; Emch, 1999), or shown the effects of diarrhea on nutritional status (Tharakan and Suchindran, 1999; Madise et al., 1999), ignoring the fact that both outcomes are potentially endogenous variables in cross-sectional design.

Third, community SES is estimated to significantly modify the association between household SES and child health, according to patterns mainly consistent with *initiating/enlarging* model. Even when interaction parameters were not statistically significant, conditional effects revealed interesting features regarding the modification of household-level effects by the community SES. This finding which is in line with works of Dargent-Molina et al. (1994) and

that of some authors cited by Stafford et al. (2001) has important policy implications as it clearly indicates that corollary measures to improve access of mothers and children to basic community resources may be necessary preconditions for higher levels of household socioeconomic situation to contribute to improved child health (Dargent-Molina, 1994). It clearly provides an additional means to targeting relevant groups of population at higher risks for childhood malnutrition and morbidity. It also provides further evidence on community effects to the debate on whether we should focus on "people" or "places" in policies and interventions regarding human health in developing countries.

Spelling out in each country the underlying mechanisms of *initiating/enlarging* or *lessening/eliminating* models is an inquiry beyond the scope of this work. It is however worth mentioning in brief that, when basic socioeconomic and health services are lacking in the poorest communities, families therein can hardly take advantage of their increased means, ability and knowledge in caring for their children. In this instance, community and household SES may interact in accordance with an *initiating/enlarging* model. Alternatively, if in the most developed neighborhoods, there are enough positive social, economic and environmental factors, increased household SES may emerge to have no additional influences on health, leading to pattern of interaction in line with *lessening/eliminating* model (Gordon et al., 2003; Reed et al., 1996). On the other hand, explaining change over time in these patterns requires further investigation. Two hypotheses are however worthy of attention. The change from DHS-1 to DHS-2 may point to poorly-measured community SES in the DHS-2 and in Egypt, in relation with the absence of community surveys. It may also have to do with the fact that most African countries have undergone sound economic, social and health sector reforms during the years 1990s that may have resulted in profound changes in the patterns of SES and well-being of populations.

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Conclusion

Cette thèse avait d'une part, un objectif méthodologique de construction de mesures du statut socioéconomique (SSE) pertinentes à l'étude des questions de santé dans les pays en développement, et d'autre part un objectif substantif d'examen de la concentration et des inégalités socioéconomiques communautaires et familiales des problèmes nutritionnels et de morbidité chez les enfants d'âge préscolaire en Afrique. Nous avons utilisé pour ce faire deux bases de données issues des Enquêtes Démographiques et de Santé (EDS) de chacun des cinq pays africains suivants : Burkina Faso (1992/93, 1998/99); Cameroun (1991, 1998); Egypte (1992, 2000); Kenya (1993, 1998) et Zimbabwe (1994, 1999). Nous consacrons ce chapitre à la présentation et discussion des principaux résultats auxquels nous sommes parvenus, de leurs implications, et à l'ébauche de quelques pistes pour les futures recherches.

1. Principaux résultats

Cette étude a développé et testé dans une perspective de comparaison entre pays et entre périodes au sein d'un même pays, un ensemble de trois mesures du SSE qui capturent les caractéristiques communautaires et familiales, et qui permettent de séparer au niveau ménage, la dimension sociale de la dimension économique et matérielle. Il s'agit (i) du statut économique du ménage défini à partir des possessions, de l'approvisionnement en eau, du type de toilettes et des caractéristiques de l'habitat ; (ii) du statut social du ménage défini à partir de l'éducation et l'occupation de la mère et du père ; et (iii) du statut socioéconomique de la communauté, construit à partir de la proportion de ménage ayant accès à l'eau potable, à l'électricité, au téléphone, ainsi que de différentes variables de disponibilité de services socioéconomiques dans la communauté lorsque les données le permettent. Les relations bivariées entre ces mesures du SSE et différentes variables de santé ressortent dans le sens attendu dans quasiment tous les pays et périodes. Elles montrent en effet une amélioration de

l'utilisation des services de santé et une baisse des taux de malnutrition et de mortalité, avec l'augmentation du SSE familial ou communautaire.

Les analyses multivariées mettent en évidence une concentration communautaire de la malnutrition et de la diarrhée chez les enfants qui persiste même après contrôle pour les caractéristiques familiales et individuelles, ce qui suggère la présence d'effets contextuels. De plus, contrairement à d'autres études, les différences entre les milieux urbains et ruraux dans la prévalence de malnutrition et la morbidité s'expliquent presque entièrement par le SSE des ménages et des communautés. Cependant, les niveaux d'inégalités socioéconomiques face à ces deux pathologies ressortent en général plus élevés en milieux urbains qu'en zones rurales, y compris après introduction des variables de contrôle.

Cette thèse montre aussi que les mesures du SSE sont fortement associées à la malnutrition et la morbidité infantiles. Des trois variables, le statut économique du ménage est le facteur qui a le plus fort pouvoir explicatif dans l'ensemble, et le SSE communautaire exerce dans certains cas une influence indépendante, notamment au Burkina Faso et en Egypte. Par ailleurs, à l'exception du Cameroun et dans une certaine mesure du Kenya, les inégalités socioéconomiques ont eu tendance à diminuer dans le temps, avec cependant des changements statistiquement significatifs dans très peu de cas. De plus, les enfants vivant dans des conditions familiales et/ou communautaires défavorisées sont plus à risque de souffrir à la fois de la malnutrition et de la diarrhée, que de souffrir seulement de l'une de ces deux pathologies.

Enfin, notre étude révèle que le SSE communautaire modifie très nettement les effets des deux variables du SSE familial, le plus souvent selon un modèle d'accentuation, en ce sens que les effets du SSE du ménage sur la malnutrition et la morbidité augmentent avec le niveau de développement socioéconomique de la communauté. Dans certains cas, cette interaction se

manifeste selon un schéma d'atténuation, les effets du SSE du ménage diminuant avec l'augmentation du SSE communautaire.

2. Discussion des résultats et implications

La construction des mesures du SSE qui capturent à la fois les caractéristiques communautaires et familiales, avec en outre une distinction entre les dimensions économique et sociale au niveau familial, nous semble être une contribution pour l'étude des questions de santé dans les pays en développement. Le fait de les appliquer à des données de plusieurs pays et à deux périodes distinctes constitue un test de robustesse. En effet, bien que plusieurs travaux aient étudié et documenté les déterminants socioéconomiques de la santé dans les pays en développement en général et africains en particulier (Kuate-Defo, 1996; Adair and Guilkey, 1997; Ricci and Becker, 1996; Armar-Klemesu et al., 2000 ; Bicego & Boerma, 1993 ; Dargent-Molina et al., 1994 ; Madise et al., 1999 ; Tharakan & Suchindran, 1999), il nous semble important d'explorer d'autres approches, en raison notamment de la complexité de la notion de SSE, dont Oakes & Rossi (2003) et Campbell & Parker (1983) indiquent que la conceptualisation et la mesure font partie des questions les plus difficiles et les plus controversées en sciences sociales. L'intérêt de prospecter d'autres méthodologies de mesure du SSE tient également à son rôle central à la fois comme déterminant de la santé et facteur influençant les autres déterminants plus proches tels que l'utilisation des services de santé, la taille et la structure familiale, les intervalles entre naissances, le statut nutritionnel de la mère, le faible poids à la naissance des enfants.

Contrairement à la plupart des études qui montrent que la malnutrition est significativement plus prévalente en milieu rural qu'en zones urbaines, et ce même après l'introduction de variables de contrôle (Adair and Guilkey, 1997; Forste, 1998; Tharakan and Suchindran, 1999), nos résultats indiquent que ces différences s'expliquent par le SSE familial et

communautaire, ce qui pourrait signifier un meilleur pouvoir explicatif de nos mesures du SSE. Nos résultats sur la concentration de la malnutrition et de la morbidité au sein des communautés sont conformes à ceux des autres auteurs qui se sont penchés sur la question (Madise et al., 1999; Subramanian et al., 2003; Frohlich et al., 2002). Ils renforcent le rôle de la communauté comme source potentielle d'influence sur la santé de ses habitants (Macintyre et al., 1993; Pickett and Pearl, 2001 ; Diez-Roux, 2001). L'effet indépendant du SSE communautaire sur la malnutrition et la morbidité qui ressort dans certains cas au Burkina Faso et en Egypte renforce davantage et matérialise cette thèse de l'influence contextuelle en santé dans les pays en développement, hypothèse largement documentée dans les pays du Nord (Mitchell et al., 2000; Matteson et al. 1998; Subramanian et al., 2001; 2003; Sundquist et al., 1999; Malmström et al., 2001; Reijneveld, 1999). De plus, la persistance d'une variabilité significative au niveau des communautés après inclusion des variables communautaires suggère l'absence dans nos modèles statistiques de caractéristiques communautaires non mesurées ou non mesurables, et qui sont pertinentes aux phénomènes que nous étudions. Nous pourrions citer par exemple les disponibilités alimentaires, les caractéristiques agro-climatiques et les données épidémiologiques.

La domination dans la plupart de nos résultats des effets du statut économique du ménage sur ceux du statut social pourrait surprendre, eu égard au rôle principal de l'effet de l'éducation maternelle -facteur compris dans l'indice social- sur la santé et la mortalité des enfants dans les pays en développement, mis en évidence par plusieurs travaux (Armar-Klemesu et al., 2000; Bicego & Boerma, 1993; Desai & Alva, 1998; Cleland & Ginneken, 1988). Le statut social -que nous avons défini- étant une combinaison de l'éducation et de l'occupation de la mère et du père, il a probablement un pouvoir explicatif moins élevé que celui de l'éducation maternelle.

Notre approche méthodologique consistant à étudier la coexistence de la malnutrition et de la diarrhée est une voie à suivre pour contourner le fait que dans les études transversales, les deux variables sont potentiellement endogènes. De plus, les résultats montrant que les enfants vivant dans des conditions défavorisées sont plus à risque de souffrir à la fois de la malnutrition et de la diarrhée que de souffrir de l'une seulement de ces deux pathologies, suggèrent une interaction entre la malnutrition et la diarrhée chez les enfants (Brown, 2003; Tomkins and Watson, 1989; Scrimshaw et al., 1968).

L'examen des différents modèles d'interaction entre SSE communautaire et SSE du ménage, ainsi que les résultats obtenus (modèles d'atténuation ou d'accentuation) est une voie qui nous a permis d'explorer un autre mécanisme de l'influence des caractéristiques communautaires sur la santé, au contraire de l'étude de Sastry (1996) qui examine plutôt l'influence de caractéristiques socioéconomiques du ménage sur les effets de facteurs socioéconomiques communautaires. Nos résultats qui sont proches de ceux obtenus par Dargent-Molina et al. (1994) et par d'autres auteurs cités par Stafford et al. (2001), suggèrent que l'amélioration de l'accès des mères et de leurs enfants à des ressources communautaires de base comme les services de santé et l'eau potable (deux des indicateurs contenus dans le SSE communautaire), pourrait être une condition préalable pour que l'amélioration du SSE des ménages contribue au bien-être des enfants (Robert, 1999 ; Gordon et al., 2003).

Au total donc, notre étude fournit une autre approche des questions des influences socioéconomiques sur la santé dans les pays en développement, et suggère entre autres que les politiques et programmes en vue d'améliorer la santé des enfants devraient inclure une dimension communautaire. Il y a cependant lieu de souligner quelques limites de notre recherche. La définition du concept de SSE nous a semblé s'écarter de notre objectif de recherche, qui est plus centré sur la structuration et l'ordonnancement d'un ensemble de

caractéristiques mesurables et mesurées dans les pays en développement, en vue d'expliquer les inégalités en santé. Pour les mêmes raisons liées au centre d'intérêt de notre étude, la méthode de construction du SSE n'inclue pas d'analyse de fiabilité, de validité et de sensibilité. De plus, la variable SSE communautaire est construite sur la base d'indicateurs différents, selon que les informations communautaires sont présentes (bases de données de la première période, sauf en Egypte) ou pas (bases de données de la second période) dans nos données. Et même lorsqu'elles sont présentes, leur contenu varie d'un pays à l'autre. Ceci pourrait avoir un impact sur les résultats relatifs aux tendances des inégalités socioéconomiques dans le temps au sein des pays, et sur ceux concernant la comparaison entre pays de l'effet indépendant du SSE communautaire.

3. Quelques pistes pour les recherches futures

Nous proposons ci-après trois directions pour des recherches futures susceptibles de compléter et approfondir certains des résultats auxquels notre étude est parvenue, ou de développer certaines questions pertinentes non abordées dans cette recherche. La première a trait aux déterminants proches de la malnutrition et de la morbidité. En raison de l'influence potentielle du SSE sur la plupart des autres facteurs qui déterminent la santé dans les pays en développement, il serait opportun de revisiter les déterminants individuels, familiaux et communautaires de l'état nutritionnel, de la santé et de la survie des enfants, notamment l'utilisation des services de santé, la taille et la structure du ménage, le statut nutritionnel de la mère, les intervalles entre naissances, et le poids à la naissance des enfants. Ceci permettrait de comparer les résultats à ceux obtenus par les autres chercheurs qui ont utilisé d'autres approches de mesure du SSE.

La deuxième piste se rapporte à l'étude de l'interaction entre le statut économique et le statut social du ménage, en vue notamment d'apporter un éclairage supplémentaire à la question de

savoir si les effets socioéconomiques sur la santé sont principalement liés à la pauvreté et aux conditions matérielles, ou aux facteurs tels l'éducation et l'emploi qui généralement précèdent la situation économique des ménages (Rahkonen et al., 2002; Lynch and Kaplan, 2000 ; Kawachi et al., 2002). Cette démarche permettrait également de tester avec d'autres mesures du SSE l'hypothèse émise par Reed et al. (1996) à savoir :

> *"... that mothers living in adverse conditions with inadequate resources, are unable to successfully apply their education to benefit their children; that within household of adequate means, there are enough positive environmental factors present that maternal behavior based on her education does not significantly improve child nutritional status; and that children expected to benefit from maternal education are those from households on intermediate conditions".*

Enfin, la troisième piste de recherche concerne l'approfondissement et l'explication des modèles d'interaction entre le SSE communautaire et le SSE familial. Nos résultats ayant mis en évidence la coexistence de modèles d'atténuation et d'accentuation, à la fois entre pays et au sein des pays pour les différentes variables étudiées (malnutrition chronique, insuffisance pondérale, diarrhée) ou les deux périodes, il serait important d'examiner les facteurs sous-jacents à ces différents modèles et à leur changement dans le temps au sein des pays.

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