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Socio-economic inequalities, gender and malnutrition in developing countries

Elodie Hafidi Alaoui

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THÈSE PRÉSENTÉE
POUR OBTENIR LE GRADE DE

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DE L'UNIVERSITÉ DE BORDEAUX**

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Spécialité Sciences Economiques

Par Elodie ROSSI, épouse HAFIDI ALAOUI

**Inégalités socio-économiques, genre et malnutrition dans
les pays en développement**

Sous la direction de Matthieu CLEMENT

Soutenue le 14 Décembre 2023

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L'Université de Bordeaux n'entend ni approuver, ni désapprouver les opinions particulières émises dans cette thèse. Ces opinions sont considérées comme propres à l'auteur.

Socio-economic inequalities, gender and malnutrition in developing countries

Elodie ROSSI, épouse HAFIDI ALAOUI

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« *La vie est une tragédie de la nutrition.* »

- Arnold Ehret

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Avant-Propos

Le travail de thèse ici présenté est le fruit d'un intérêt accru, au fil des ans, pour la Science Économique telle que conçue à ses origines dans l'Antiquité Grecque. Je fais ici référence à l'économie domestique, s'attachant à gérer de façon optimale les ressources limitées d'un groupe social particulier. À l'époque, il s'agissait généralement de la famille ou de la communauté religieuse, c'est-à-dire une communauté humaine définie par des liens sociaux forts. À partir du 17^e siècle, cet art d'administrer les ressources à un échelon local a été transposé à la sphère étatique : la population attendant du Prince/législateur, le comportement sage et économe du père ou de la mère de famille (Steiner, 2006)¹. Dès lors, il s'agit de concevoir la Science Économique comme l'administration de ressources mondiales limitées à une société en expansion aux besoins illimités, tout en attribuant à chacun la part qui lui revient. Inévitablement, le défi et les enjeux sont de taille. Toutefois, il nécessite de garder à l'esprit l'essence de la matière et ses objectifs initiaux, bien que portés à plus grande échelle.

Dans cette perspective, je me suis formée à devenir économiste du développement, une branche particulière de l'économie née après la Seconde Guerre mondiale. Ici, l'objet d'étude n'est plus la croissance, issue d'une vision unidimensionnelle, mais le « développement », dans une acceptation multidimensionnelle. En tant que microéconomiste du développement, je me suis spécialisée à un échelon d'étude plus individualisé, soucieuse de garantir une croissance économique bénéfique à l'accroissement du bien-être des populations. Au cours de cette thèse, j'ai plus particulièrement choisi de me questionner sur l'étude de leur santé. En effet, comme l'évoque Wacquant (1995)², le corps peut être considéré comme une forme de capital à part entière, qu'il nomme « capital corporel », conditionnant les possibilités d'interaction des hommes au sein de la société. Cette santé, dotation génétique acquise, évolue au gré des circonstances socio-économiques, qui peuvent lui être favorables ou défavorables. Cet environnement socio-économique est déterminant puisqu'il façonne en réalité les deux tiers de la santé des populations, relayant l'importance de la transmission génétique au second plan

¹ Steiner, P. (2006). La science de l'économie politique et les sciences sociales en France (1750-1830). *Revue d'histoire des sciences humaines*, (2), 15-42.

² Wacquant, L. J. (1995). Pugs at work: Bodily capital and bodily labor among professional boxers. *Body & society*, 1(1), 65-93.

(Thompson, 2014)³. De ce fait, à l'instar des médecins ou épidémiologistes, l'étude de la santé des populations occupe une part importante de la recherche en économie.

Dans cette thèse, nous traiterons des questions de malnutrition et d'inégalités socio-économiques dans les pays en développement, tout en appréhendant ces questionnements sous le prisme du genre. Le but de cette réflexion est de souligner l'importance cruciale de la notion de genre pour comprendre les enjeux sociétaux actuels, et à venir, en termes de nutrition et de santé des populations. Cette thèse est présentée en vue de l'obtention du titre de Docteur en économie, spécialisée sur les questions de développement, de santé et de genre, confirmant mon appétence dans ces domaines. Plus particulièrement, ce travail est celui d'une femme, d'une épouse et d'une mère à venir, exploitant sa condition et ses compétences acquises afin de les mettre au service de la construction d'un monde meilleur.

J'espère que le lecteur appréciera la volonté d'ébauche faite sur ces questionnements, travail sans doute perfectible au cours d'une longue carrière de chercheur, je l'espère.

³ Thompson, O. (2014). Genetic mechanisms in the intergenerational transmission of health. *Journal of Health Economics*, 35, 132-146.

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Parmi toutes les personnes que je souhaite remercier, je tiens d'abord à exprimer ma gratitude envers *Sandrine BRIEC*, professeur de Sciences Économiques et Sociales. Grâce à sa pédagogie remarquable, elle a suscité en moi le désir d'approfondir davantage les mécanismes de l'économie. Mon expérience à l'Université de Bordeaux a ensuite renforcé mon intérêt pour les Sciences Économiques et m'a permis de rencontrer d'autres personnes marquantes que je tiens à saluer.

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C'est au sein de ce laboratoire que j'ai fait de belles rencontres humaines, venant d'horizons divers et variés, chacune laissant une empreinte singulière. Je tiens à remercier *Suneha SEETAHUL* pour avoir pris le temps de partager brièvement son expérience de thèse, même avant que je ne pose ma candidature. Un grand merci à *Viola, Jeanne, Bao, Lionel, Elodie, François, Samuel, Dan, Lucie, Lucile, Valentina, Thomas* et *Louis* pour m'avoir immergé dans la réalité quotidienne de la thèse en partageant vos propres expériences. Je souhaite également exprimer ma reconnaissance envers mes camarades de promotion du master qui ont rejoint cette aventure, contribuant ainsi à la rendre encore plus enrichissante. Je pense tout particulièrement à *Marine, Damien, Laura, Léo* et *Christian*. Je remercie également les autres rencontres, tant les anciens que les nouveaux venus au fil du temps, qui ont rendu cette expérience des plus agréables. En particulier, *Jérémy, Sébastien, Arnaud*, et enfin *Diane*, méritent toute ma gratitude. Et enfin, un grand merci à toutes les autres rencontres enrichissantes qui se sont multipliées au fil du temps, parmi lesquelles *Erwan, Jemal, Badr, Josias, Florian, Mampian, Oudah, Gaëlle* et *Nicolas*. Sachez que chacun d'entre vous a contribué de manière significative à l'élaboration de ce manuscrit !

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Résumé en français

Selon l'Organisation Mondiale pour la Santé (OMS)⁴, la malnutrition qui s'exprime sous différentes formes, de carences ou d'excès, fait plus généralement référence à tout déséquilibre dans l'apport énergétique ou nutritionnel d'une personne. Plus spécifiquement, ce terme générique fait écho à une variété de réalités que l'on peut regrouper en trois grandes catégories. La première catégorie se réfère à la dénutrition et se caractérise par la famine ou la sous-alimentation. Ce type de malnutrition s'incarne sous la forme de retards de croissance (faible rapport taille/âge), d'émaciations (faible rapport poids/taille) ou d'insuffisances pondérales (faible rapport poids/âge). La seconde catégorie fait référence aux maladies non-transmissibles liées au régime alimentaire telles que le surpoids, l'obésité, le diabète, les maladies cardiovasculaires et les cancers. Enfin, la malnutrition fait également référence à des situations dans lesquelles les vitamines et les minéraux essentiels, appelés micronutriments, sont soit en excès, soit insuffisamment fournis. Prise sous l'ensemble de ces formes, la malnutrition reste la principale cause de mortalité et de morbidité à l'échelle mondiale, ce qui en fait la problématique de santé mondiale la plus préoccupante (Afshin et al., 2019).

Malheureusement, les dernières estimations dressent un sombre tableau de la lutte mondiale contre la malnutrition, et les objectifs fixés semblent difficiles à atteindre. En 2019, la pandémie de COVID-19 a plongé davantage de personnes dans une insécurité alimentaire modérée ou grave. Plus récemment, la guerre russo-ukrainienne a exacerbé l'ensemble des problématiques de malnutrition, dans la mesure où les deux parties belligérantes sont également les plus grands producteurs mondiaux de céréales de base, d'oléagineux et d'engrais. Ainsi, en 2021, l'inflation a laissé plus de 3,1 milliards de personnes dans l'incapacité de se procurer quotidiennement des aliments nutritifs (FAO, IFAD, UNICEF, WFP and WHO, 2023). Selon l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO, IFAD, UNICEF, WFP and WHO, 2023), entre 690 et 783 millions de personnes souffraient encore de la faim en 2022, une situation qui souligne le caractère persistant et urgent du problème de la malnutrition.

En outre, le défi de la lutte contre la malnutrition est encore plus grand que mentionné précédemment, car des problèmes non résolus de dénutrition coexistent désormais avec l'émergence de problèmes de surnutrition, communément appelés le « double fardeau de la

⁴ Définition de l'OMS, disponible sur : [Malnutrition \(who.int\)](https://www.who.int/fr/about-us/who-terminology/malnutrition) (consulté le : 12/10/2023).

malnutrition » (World Health Organization, 2016). D'une part, de récentes estimations de l'Organisation des Nations Unies pour l'alimentation et l'agriculture⁵, ont révélé que la prévalence de la faim, qui s'était stabilisée depuis 2015, a augmenté depuis 2019 et a atteint 9,8 % de la population mondiale en 2021. D'autre part, l'OMS⁶ fait état d'une augmentation inquiétante de l'obésité, le nombre de cas ayant triplé depuis 1975. Ainsi, en 2016, 39 % des adultes étaient en surpoids, et 13 % d'entre eux étaient classés comme obèses. La situation est tout aussi alarmante chez les enfants, l'obésité infantile étant passée de seulement 4 % en 1975 à un peu plus de 18 % en 2016. Parmi les principales causes de cette montée rapide des taux de surpoids et d'obésité, l'étude d'Allen et al. (2023) montre que près de 46 % des enfants n'incluent aucun fruit ou légume dans leur alimentation quotidienne.

Du point de vue de la santé, la malnutrition affecte le fonctionnement et la récupération de l'ensemble du système organique, c'est-à-dire les fonctions musculaires, cardio-respiratoires et gastro-intestinales, mais aussi l'immunité et la cicatrisation des individus (Saunders & Smith, 2010). Au niveau social, la malnutrition peut être stigmatisante et aboutir à divers effets psychosociaux tels que la dépression, l'anxiété ou le suicide, au regard des normes sociétales en vigueur. Dans les pays à hauts revenus, où la minceur est socialement valorisée, le surpoids ou l'obésité peuvent en effet causer une détresse émotionnelle (Brewis et al., 2018). D'une autre manière, la dénutrition, plus répandue dans les pays à revenu faible ou intermédiaire, affecte la chimie et le développement du cerveau dès le plus jeune âge et peut également conduire à la dépression (de Souza et al., 2023). D'un point de vue économique, la malnutrition augmente les dépenses en soins de santé, réduit les rendements éducatifs, la productivité au travail et ralentit le potentiel de croissance économique (e.g. Black et al., 2008; Horton & Steckel, 2013). Enfin, certaines études ont mis en évidence l'impact environnemental que peuvent représenter ces problématiques de malnutrition. À titre d'exemple, l'obésité a un impact environnemental du fait de divers facteurs comme l'augmentation du métabolisme oxydatif des individus, une consommation alimentaire plus importante et une consommation accrue de carburant en matière de transport des personnes (Salines, 2020). Pour toutes ces raisons, la malnutrition est une problématique d'un intérêt crucial qui revêt des conséquences à la fois médicales, sociales, économiques et environnementales, aussi bien pour les individus que pour les pays.

⁵ [D'après un rapport de l'ONU, la faim dans le monde progresse et pourrait avoir touché jusqu'à 828 millions de personnes en 2021 \(fao.org\)](#) (consulté le : 12/10/2023).

⁶ [Principaux repères sur l'obésité et le surpoids \(who.int\)](#) (consulté le : 12/10/2023).

À la lumière des défis décrits ci-dessus, il est essentiel de redéfinir un ensemble de politiques publiques efficaces pour s'attaquer au « double fardeau » de la malnutrition, voire au « triple fardeau » si l'on considère les carences croissantes en micronutriments (Bose et al., 2022). Concernant la sous-nutrition⁷, l'objectif principal est d'encourager la production d'aliments nutritifs et sains (en mettant l'accent sur les fruits, les légumes et les légumineuses) tout en réorientant les politiques agricoles pour qu'elles profitent directement aux agriculteurs, et en promouvant des pratiques durables sur le plan de l'environnement. Du côté de la « demande », les approches promouvant d'autres politiques, telles que les programmes de transferts monétaires conditionnels, peuvent également accroître la couverture et la qualité des services de santé et de nutrition (Leroy et al., 2009). En ce qui concerne les problématiques de surnutrition⁸, la réduction de la charge du surpoids et de l'obésité revient en partie à la modification des comportements individuels : limitation de l'apport énergétique (sucres, graisses et sel provenant d'aliments transformés), consommation accrue d'aliments sains (fruits, légumes, céréales complètes et oléagineux) et pratique d'une activité physique régulière (150 minutes par semaine pour les adultes selon la littérature (*e.g.*, Jakicic et al., 2001)). Toutefois, les efforts ne peuvent reposer uniquement sur les individus et les gouvernements doivent agir. L'un des défis des gouvernements est notamment de promouvoir la disponibilité et l'accès, notamment financier, à une activité physique régulière et aux changements d'habitudes alimentaires. Le secteur privé, y compris l'industrie agro-alimentaire, a également un rôle clé à jouer dans ce changement de régime alimentaire.

Du point de vue de la recherche scientifique, il est essentiel de comprendre les déterminants de la malnutrition, ce qui nécessite de considérer l'ensemble de l'environnement socio-économique des individus (y compris les facteurs économiques, sociaux et culturels) qui influence profondément l'accès à une alimentation saine et les comportements associés. À ce sujet, il faut d'abord mentionner que la malnutrition est profondément ancrée dans les inégalités sociales et économiques, les personnes vivant dans la pauvreté étant plus exposées à un risque de malnutrition (Van de Poel et al., 2008; World Health Organization, 2021). Néanmoins, supposer une relation linéaire sur cette question reviendrait à négliger la complexité et les nuances de la réalité de la malnutrition (Siddiqui et al., 2020). Même si la pauvreté et la malnutrition se

⁷ [D'après un rapport de l'ONU, la faim dans le monde progresse et pourrait avoir touché jusqu'à 828 millions de personnes en 2021 \(fao.org\)](#) (consulté le 12/10/2023).

⁸ [Principaux repères sur l'obésité et le surpoids \(who.int\)](#) (consulté le : 12/10/2023).

renforcent mutuellement, la pauvreté n'est pas le seul déterminant de ces problèmes. En effet, la pauvreté, telle que théorisée par Bourdieu (1979), doit être envisagée dans ses aspects multidimensionnels, qui peuvent s'exprimer par des désavantages dans une ou plusieurs formes de « capital », à savoir : le capital économique (ressources financières), le capital social (appartenance à un groupe et relations connexes), le capital symbolique (position sociale) et le capital culturel (niveau d'éducation et normes sociétales). Ainsi, au-delà des déterminants micro-économiques de la malnutrition, d'autres facteurs macro-économiques entrent également en jeu. Plus particulièrement, chaque pays connaît différentes formes de malnutrition, avec des caractéristiques spécifiques selon son niveau de développement économique. D'une manière générale, les pays passent progressivement de la sous-alimentation à la suralimentation, ce que Popkin (2011) appelle une « transition nutritionnelle »⁹. Pendant cette transition, les pays en développement sont les plus vulnérables à ce double fardeau de la malnutrition (Leocádio et al., 2021), en particulier les populations à faible revenu des pays à revenus faibles ou intermédiaires (Hansford, 2010). Cette vulnérabilité peut être attribuée à la cohabitation de deux situations différentes : la persistance de conditions environnementales défavorables et de pauvreté, qui ne parviennent pas à résoudre les problèmes de dénutrition ; et des changements économiques, sociaux, technologiques et de mode de vie rapides qui conduisent à une augmentation simultanée du surpoids et de l'obésité.

Selon le cadre conceptuel de lutte contre la malnutrition du Fonds international d'urgence des Nations Unies pour l'enfance (UNICEF)¹⁰, les femmes et leur progéniture constituent les groupes de population les plus vulnérables. Les enfants dépendant largement de leur mère, les femmes apparaissent donc comme le levier le plus important à mobiliser dans la lutte contre la malnutrition. Les politiques publiques axées sur l'amélioration de l'état nutritionnel des enfants doivent notamment s'intéresser à la situation des mères pour de nombreuses raisons. Premièrement, l'état nutritionnel des femmes, avant et pendant la grossesse, est un déterminant essentiel de l'issue saine de la grossesse (Kramer, 1987 ; Kramer & Victora, 2001), affectant le poids de naissance de l'enfant (Abubakari & Jahn, 2016 ; Matin et al., 2008). Par exemple, la dénutrition maternelle est généralement associée à un retard de croissance intra-utérin et à un

⁹ Le processus de « transition nutritionnelle » fait référence à « des changements majeurs dans les modèles d'apport alimentaire et de dépenses en nutriments... » (Monteiro et al., 2004, p. 433) qui ont modifié l'IMC des personnes en raison de la modernisation, de la technologie, de la mondialisation et de l'industrie alimentaire sur la biologie humaine.

¹⁰ [Cadre conceptuel de l'UNICEF | UNICEF](#) (consulté le : 12/10/2023).

faible poids à la naissance (Fishman et al., 2004). Ce faible poids à la naissance ou cette prise de poids accélérée après l'âge de deux ans (ou une combinaison des deux) prédispose à l'obésité, à l'hypertension, aux maladies cardio-vasculaires et au diabète de type 2 à l'âge adulte (Barker et al., 2005). À l'inverse, un nombre croissant de preuves documentent les effets du surpoids ou de l'obésité maternelle sur le risque de maladie chez la progéniture. Ces risques comprennent l'obésité, les maladies coronariennes, les accidents vasculaires cérébraux, le diabète de type 2, l'asthme et les troubles neuro-développementaux et cognitifs chez les enfants (Godfrey et al., 2017). Deuxièmement, la littérature s'accorde sur le fait qu'optimiser la nutrition au cours des 1 000 premiers jours de la vie d'un enfant est essentiel pour lui offrir le meilleur départ possible (Saavedra & Dattilo, 2022). Là encore, les mères ont un rôle clé à jouer. Par conséquent, les faits antérieurs expliquent pourquoi les organisations internationales de développement se concentrent progressivement sur les femmes et leur autonomisation progressive pour obtenir de meilleurs résultats nutritionnels pour les enfants. Nos recherches s'inscrivent dans ce contexte et mettent en lumière diverses problématiques de santé nutritionnelle dans une perspective de genre.

Le droit de bénéficier du meilleur état de santé possible est l'un des droits fondamentaux de l'homme (OMS, 1946 et article 25 de la Déclaration Universelle des Droits de l'Homme). Afin d'atteindre cet objectif, cette thèse vise à mieux informer les partenaires privés, nationaux et internationaux sur la situation actuelle et les défis dans le domaine de la nutrition. Plus précisément, nous savons que le rôle des femmes a évolué à mesure que les sociétés se développaient, avec un arbitrage constant entre le rôle productif (qualifié de « culturel ») et le rôle reproductif (qualifié de « naturel »). Dans cette optique, cette thèse défend la nécessité de prendre en compte les relations de genre dans la compréhension des changements nutritionnels en cours dans les pays en développement. En résumé, nous soutenons que le concept de genre est l'un des déterminants essentiels de la malnutrition et des inégalités existantes à cet égard. A partir de cette thématique générale liant les inégalités de malnutrition et la notion de genre, nous avons formulé trois questions de recherche correspondant aux trois articles/chapitres qui composent la thèse. Le chapitre 1 se concentre sur une étude de cas spécifique, le Népal, un exemple pertinent de pays combinant malnutrition infantile et faibles niveaux d'autonomisation des femmes. Le chapitre 2 discute de l'évolution des pratiques d'allaitement maternel avec l'enrichissement des populations et des pays du continent asiatique. Quant au chapitre 3, il propose une étude comparative entre pays de l'évolution temporelle des problématiques de surnutrition liées à l'évolution des attitudes à l'égard des rôles de genre.

La thèse est structurée pour s'aligner sur sa séquence conceptuelle. Celle-ci commence par l'analyse d'un pays, progresse vers un ensemble de données combinées englobant la région asiatique et culmine par la proposition d'une étude macro-économique plus large. Sur le plan méthodologique, la thèse s'appuie sur des données micro et macro-économiques secondaires en utilisant diverses méthodes statistiques et économétriques. Les analyses proposées s'inscrivent dans le domaine de l'économie appliquée et se situent à l'intersection des études sur le développement, la santé et l'économie du genre.

Chapitre 1 : Malnutrition infantile au Népal : Autonomisation des femmes ou promotion de leur statut socio-économique ? (Auteur unique : E. ROSSI)

Dans le premier chapitre, nous examinons l'impact d'un empowerment en termes de pouvoir sur la nutrition infantile au Népal, tout en considérant les effets interactifs avec le statut socio-économique des femmes. Cette recherche s'inscrit dans le contexte du débat autour de la notion d'empowerment, débat opposant deux visions distinctes. La première est celle portée par les féministes à l'origine du concept et défend la promotion du pouvoir chez les femmes, comme fin en soi. La seconde est celle promue par les institutions internationales et vise à améliorer le statut socio-économique des femmes, comme moyen de lutte contre la pauvreté. Nos analyses sont basées sur les données de l'Enquête Démographique et de Santé (EDS) du Népal pour l'année 2016. À l'aide d'analyses en composantes multiples, nous construisons un indicateur de statut socio-économique des mères (richesse du ménage, niveau éducatif et type d'emploi) et un indicateur d'autonomisation non-économique (non-acceptation de la violence domestique, accès à la santé, pouvoir de prise de décisions et aide communautaire). Les effets de nos variables d'intérêt sont observés sur la taille-pour-âge d'enfants de 6 à 59 mois (Z-score), et la diversité alimentaire de ceux ayant entre 24 et 59 mois (score sur 8 groupes d'aliments). À l'aide d'outils économétriques, nous exécutons des régressions linéaires multivariées et limitons les biais d'endogénéité par une stratégie de variables instrumentales. Nous appréhendons également l'hétérogénéité de nos résultats en les analysant par sous-échantillons : d'âge (plus ou moins de 24 mois), de lieu de résidence (urbain/rural) et de sexe (fille/garçons). Nos résultats mettent en avant l'importance d'un empowerment en termes de « pouvoirs » pour de meilleurs résultats nutritionnels infantiles au Népal. Cet empowerment permet par ailleurs d'atténuer les effets néfastes d'un faible statut socio-économique maternel. L'impact positif de cette forme d'empowerment est plus fort chez les filles que les garçons, contribuant à réduire les biais de genre dans le pays (préférence pour les garçons). Enfin, nous tenons à souligner que

tout en promouvant l'amélioration du statut socio-économique des femmes, il est important de reconnaître que cela peut avoir des effets mitigés sur la nutrition des enfants. Alors que nous considérons l'éducation des femmes comme essentielle, nous devons également prendre en compte l'intégration économique des femmes, en particulier dans le secteur agricole. Cela peut entraîner une augmentation de la diversité alimentaire, mais il est important de noter que cela pourrait également avoir des effets négatifs à long terme sur la croissance des enfants. Nous concluons sur les avantages d'une autonomisation des femmes portée sur les aspects non-économiques pour lutter contre la sous-nutrition des jeunes enfants népalais.

Chapitre 2 : « Mother's milk » : existe-t-il un renversement social des pratiques d'allaitement maternel au cours du développement économique ? (Co-écrit : E. ROSSI; P. LEVASSEUR; M. CLEMENT)

Dans le second chapitre, nous testons l'existence d'un renversement de l'association entre la richesse des ménages et les pratiques d'allaitement optimales, au cours du processus de développement des pays asiatiques. A cet effet, nous mobilisons une base de données ambitieuse combinant 42 Enquêtes Démographiques et de Santé, couvrant 15 pays d'Asie sur la période (1990-2017). Nous construisons quatre indicateurs de pratiques d'allaitement optimales (exclusivité, initiation précoce et continuité à un et deux ans) et un indicateur de richesse (sur la base des actifs du ménage) permettant la comparaison entre les différentes vagues d'enquêtes et pays. Économétriquement, nous analysons l'association richesse-allaitement en incluant des termes d'interaction entre richesse des ménages et niveau de développement économique des pays (faible, moyen et élevé) ou le temps. Nous tentons par ailleurs de limiter les biais d'endogénéité par des estimations en variables instrumentales. Nos résultats confirment l'existence d'une transition dans le gradient richesse-allaitement en Asie, notamment sur l'exclusivité de la pratique et sa continuité. Ainsi, ces pratiques traditionnellement pro-pauvres se propagent progressivement aux ménages les plus riches au cours du développement économique. Si le renversement s'opère intégralement du côté de l'exclusivité, il est un peu moins marqué en termes de continuité. Nous expliquons ces résultats par la mise en œuvre de *Baby-Friendly Hospital Initiatives*, qui ont permis de réduire l'usage d'aliments pré-lactés chez les plus riches bien que la pratique reste attractive pour les plus pauvres. Nos résultats ne mettent en revanche pas en évidence de renversement des pratiques en matière d'initiation précoce de l'allaitement. Nous observons de lents progrès partagés par l'ensemble des classes sociales. Nous l'expliquons, d'une part, par les bienfaits de la hausse des

suivis prénataux et le recul des accouchements domestiques. D'autre part, la pratique semble freinée par certaines contraintes telles que la prolifération des césariennes. Finalement, nous soulignons la nécessité de mettre en place des politiques pro-pauvres qui soutiennent l'allaitement maternel concomitamment à l'insertion économique des femmes sur le marché du travail. Ces résultats sont cruciaux en termes de politiques publiques puisque l'allaitement représentait jusqu'alors une des seules pratiques pro-pauvres permettant de réduire les inégalités de santé entre riches et pauvres.

Chapitre 3 : Transformation des attitudes liées au rôle de genre : un mécanisme socioculturel de l'épidémie d'obésité. (Auteur unique : E. ROSSI)

Dans le troisième chapitre, nous examinons l'impact de la transformation des attitudes liées aux rôles de genre sur l'écart d'obésité entre les sexes chez l'adulte et sur la prévalence de l'obésité pour chaque sexe. Pour ce faire, nous utilisons une base de données de panel construite à partir de données de l'OMS et de la Banque mondiale, couvrant 168 pays sur 27 ans (1990-2016). Nous mesurons les attitudes de genre de deux façons : a) via l'indice Femmes Entreprises et Droit (WBL) de la Banque Mondiale, b) via un indicateur multidimensionnel plus large construit par analyse en composantes principales combinant trois dimensions (l'indice WBL, le taux de fécondité et la participation des femmes sur le marché du travail). D'un point de vue économétrique, nous mobilisons des régressions à effets fixes individuels et temporels et limitons les biais d'endogénéité par des estimations en variables instrumentales. Nos résultats mettent en exergue une augmentation transitoire de l'écart des sexes en matière d'obésité (défavorable aux femmes) suite au passage à des valeurs plus progressistes/féministes, impliquant à terme une réduction de l'écart d'obésité entre les sexes. S'agissant de la prévalence à l'obésité, nous démontrons une relation genre-obésité qui prend la forme d'un U chez les hommes et d'un U-inversé chez les femmes. En d'autres termes, l'excès d'obésité chez les femmes des sociétés traditionnelles laisse place à un excès d'obésité chez les hommes des sociétés modernes. Une réduction de l'écart d'obésité entre les sexes ne signifie donc pas nécessairement d'avancées dans la lutte contre l'obésité. Certes, nous observons un déclin de l'écart d'obésité entre les sexes, mais avec une hausse globale de la prévalence de l'obésité. Cette montée des taux d'obésité est notamment marquée par l'accroissement de l'obésité masculine tandis qu'à plus hauts niveaux d'attitudes de genre égalitaires, l'obésité féminine décroît. Ces résultats soulignent le rôle des attitudes de genre dans le processus de transition nutritionnelle et l'épidémie d'obésité.

General introduction

According to the World Health Organization (WHO),¹¹ malnutrition describes an imbalance in one person's energy and/or nutrient intake, manifested by various deficiencies or excesses. Specifically, this broad term addresses various situations that can be grouped into three main categories. The first category refers to undernutrition and is characterized by starvation or undernourishment. This form of malnutrition is manifested by stunting (low height-for-age), wasting (low weight-for-height) or underweight (low weight-for-age). The second category refers to overnutrition and encompasses various diet-related non-communicable diseases such as overweight, obesity, diabetes, heart disease, stroke and some cancers. Lastly, malnutrition also refers to situations where essential vitamins and minerals, referred to as micronutrients, are either over- or under-supplied. In all its various forms, malnutrition remains the foremost cause of both mortality and morbidity on a global scale, making it the most pressing global health concern (Afshin et al., 2019).

Unfortunately, the latest estimates paint a bleak picture of the global fight against malnutrition, and the targets set appear challenging to achieve. In 2019, the COVID-19 pandemic has pushed more people into moderate or severe food insecurity. More recently, the Russo-Ukrainian war has exacerbated these malnutrition problems, as the two warring parties are also the world's largest producers of staple grains, oilseeds, and fertilizers. As a result, the inflation has left over 3.1 billion people unable to afford nutritious food daily in 2021 (FAO, IFAD, UNICEF, WFP and WHO, 2023). According to the Food and Agriculture Organization (FAO, IFAD, UNICEF, WFP and WHO, 2023), between 690 million and 783 million people still struggle with hunger in 2022, a situation underscoring the persistent and urgent nature of the malnutrition challenge.

Furthermore, the challenge of tackling malnutrition is even greater than previously mentioned, as unresolved issues of undernutrition now coexist with the emergence of issues of overnutrition, commonly referred to as the "double burden of malnutrition" (World Health Organization, 2016). On the one hand, recent estimates from the FAO¹² revealed that the prevalence of hunger, which had stabilized since 2015, has risen since 2019 and reached 9.8%

¹¹ <https://www.who.int/news-room/fact-sheets/detail/malnutrition> (accessed on: 10/10/2023).

¹² <https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en> (accessed on: 10/10/2023).

of the global population in 2021. On the other hand, the WHO¹³ reported a worrying rise in obesity, with cases having tripled since 1975. Hence, 39% of adults were overweight, and 13% of them were classified as obese in 2016. The situation is equally alarming concerning children, with childhood obesity having increased from just 4% in 1975 to just over 18% in 2016. Among the leading causes, the study of Allen et al. (2023) shows that 45.7% of children do not include any fruit or vegetables in their daily diet.

From a health perspective, malnutrition affects the functioning and recovery of the entire organic system, including muscular, cardiorespiratory and gastrointestinal functions, as well as individuals' immunity and healing capacity (Saunders & Smith, 2010). At the social level, malnutrition can be stigmatizing and, given prevailing social norms, can lead to various psychosocial outcomes such as depression, anxiety or suicide. In high-income countries, being overweight or obese can cause emotional distress, as thinness is socially valued (Brewis et al., 2018). In another way, undernutrition, which is more prevalent in low- and middle-income countries (LMICs), may also lead to depression by affecting brain chemistry and development from an early age (de Souza et al., 2023). From an economic point of view, malnutrition contributes to increased healthcare costs, reduces educational attainment and labor productivity, and slows economic growth potential (*e.g.*, Black et al., 2008; Horton & Steckel, 2013). In addition, some studies have highlighted the environmental impacts associated with some of these malnutrition issues. For instance, obesity has an environmental impact due to increased oxidative metabolism in individuals, food consumption, and fuel consumption for transport (Salines, 2020). For all these reasons, malnutrition is a critical issue with medical, social, economic and environmental implications for individuals and countries.

In light of the challenges outlined above, it is essential to redefine a set of effective public policies to address the "double burden" of malnutrition or even the "triple burden" if we consider the growing micronutrient deficiencies (Bose et al., 2022). For undernutrition¹⁴, one main objective is to encourage the production of nutritious and healthy foods (with a focus on fruits, vegetables, and pulses) while reorienting agricultural policies to benefit farmers directly and promoting environmentally sustainable practices. On the "demand" side, approaches promoting other policies, such as conditional cash transfer programs, may also increase the

¹³ <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> (accessed on: 10/10/2023).

¹⁴ <https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en> (accessed on: 10/10/2023).

coverage and quality of health and nutrition services (Leroy et al., 2009). Regarding overnutrition¹⁵, reducing the burden of overweight and obesity depends in part on changing individual behavior: limiting energy intake (sugars, fats, and salt from processed foods), increasing consumption of healthy foods (fruits, vegetables, whole grains, and nuts) and regular physical activity (150 minutes per week for adults according to the literature (*e.g.*, Jakicic et al., 2001)). However, efforts cannot rely on individuals alone, and governments must act. One of the governments' challenges, in particular, is to promote availability and access, especially financial access, to regular physical activity and changes in eating habits. Besides, the private sector, including business agri-food, has a crucial role to play in the dietary changes needed.

From the scientific research perspective, it is essential to understand the determinants of malnutrition, which requires considering individuals' whole socio-economic environment (including economic, social, and cultural factors) that profoundly influences access to healthy food and related behaviors. On the matter, we first must mention that malnutrition is deeply rooted in social and economic inequalities, with people experiencing poverty at higher risk of malnutrition (Van de Poel et al., 2008; World Health Organization, 2021). Nevertheless, assuming a linear relationship on this issue would overlook the complexity and nuances of the reality of malnutrition (Siddiqui et al., 2020). Even if poverty and malnutrition mutually reinforce each other, poverty is not the only determinant of these issues. Indeed, poverty, as theorized by Bourdieu (1979), must be envisaged in its multidimensional aspects, which can be expressed in disadvantages in one or more forms of "capital," namely: economic capital (financial resources), social capital (group membership and related relationships), symbolic capital (social position) and cultural capital (level of education and societal norms). Hence, beyond the microeconomic determinants of malnutrition, other macroeconomic factors are also at play. More particularly, each country experiences different forms of malnutrition, with specific characteristics depending on its economic development level. Broadly speaking, countries gradually move from undernourishment to overnourishment, referred to as a "nutrition transition"¹⁶ by Popkin (2011). During this transition, developing countries are the

¹⁵ <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> (accessed on: 10/10/2023).

¹⁶ The "nutrition transition" process refers to "major shifts in dietary intake and nutrient expenditure patterns..." (Monteiro et al., 2004, p. 433) that have changed people's BMI undergoing modernisation, technology, globalisation and the food industry on human biology. Among the major changes that have led to widespread energy imbalance are the replacement of traditional water and breast milk consumption with high-calorie drinks and the increase in the frequency and size of meals (Popkin, 2011).

most vulnerable to this double burden of malnutrition (Leocádio et al., 2021), especially low-income populations in LMICs (Hansford, 2010). This vulnerability can be attributed to the cohabitation of two different situations: the persistence of adverse environmental conditions and poverty, which fail to address undernutrition issues; and rapid economic, social, technological, and lifestyle changes that lead to a simultaneous increase in overweight and obesity.

According to the conceptual framework for the fight against malnutrition of the United Nations International Children's Emergency Fund (UNICEF)¹⁷, women and their offspring are the most vulnerable population groups. As children largely depend on their mothers, women, therefore, appear to be the most important lever to mobilize in the fight against malnutrition. Public policies focusing on improving children's nutritional status must notably be interested in the situation of mothers for many reasons. First, women's nutritional status, before and during pregnancy, is an essential determinant of healthy pregnancy outcomes (Kramer, 1987; Kramer & Victora, 2001), which affects a child's birth weight (Abubakari & Jahn, 2016; Matin et al., 2008). For instance, maternal undernutrition is commonly associated with intrauterine growth restriction and low birth weight (Fishman et al., 2004). This low birth weight or accelerated weight gain after two years of age (or a combination of both) predisposes to obesity, hypertension, cardiovascular disease, and type 2 diabetes in adulthood (Barker et al., 2005). Conversely, another growing body of evidence documents the effects of maternal overweight or obesity on the risk of offspring disease. These risks include obesity, coronary heart disease, strokes, type 2 diabetes, asthma, and neurodevelopmental and cognitive disorders in children (Godfrey et al., 2017). Second, the literature agrees that optimizing nutrition in the first 1,000 days of a child's life is essential to give him/her the best possible start (Saavedra & Dattilo, 2022). Here again, mothers have a key role to play. Consequently, previous facts explain why international development organizations progressively focus on women and their progressive empowerment to achieve better nutritional outcomes for children. Our research fits into this context and sheds light on various nutritional health issues from a gender perspective.

The right to benefit from the highest attainable standard of health is one of the fundamental human rights (OMS, 1946 et article 25 de la Déclaration Universelle des Droits de l'Homme). In order to achieve this goal, this thesis aims to better inform private, national and international

¹⁷ [UNICEF Conceptual Framework | UNICEF](#) (accessed on: 10/10/2023).

partners about the current situation and challenges in the field of nutrition. Specifically, we know that women's roles have evolved as societies have developed, with a constant trade-off between productive roles (referred to as "cultural") and reproductive roles (referred to as "natural"). With this in mind, this thesis advocates the need to consider gender relations in understanding ongoing nutritional changes in both developing and developed countries. In summary, we argue that the concept of gender is one of the critical determinants of malnutrition and existing inequalities in this regard. From this general theme linking malnutrition inequalities and the concept of gender, we have formulated three research questions corresponding to the three articles/chapters that make up the thesis. Chapter 1 focuses on a specific case study, Nepal, a pertinent example of a country combining child malnutrition and low levels of women's empowerment. Chapter 2 discusses the evolution of maternal breastfeeding practices with the enrichment of populations and countries in the Asian continent. As for Chapter 3 it proposes a cross-country comparative study of the time evolution of over-nutrition linked to changing attitudes toward gender roles. Before proceeding to the individual chapters, the following pages provide a step-by-step introduction to the research topic. Section 1 discusses the issue of malnutrition as a marker of socio-economic inequalities and a potential vicious circle for their reproduction. Section 2 highlights the importance of women's role in malnutrition issues, introduces the concept of women's empowerment and discusses its relevance to the challenges previously mentioned. Finally, section 3 proposes a summary of each chapter.

The thesis is structured to align with its conceptual sequence. It begins with the analysis of a country, progresses to a combined dataset encompassing the Asian region, and culminates in the proposition of a broader macroeconomic study. Methodologically, the thesis draws upon secondary micro- and macroeconomic data using various statistical and econometric methods. The proposed analyses fall within the field of applied economics and lie at the intersection of development, health, and gender economics studies.

1. "Dominated bodies and minds": Nutrition as a marker of socio-economic inequalities and a vector for their reproduction.

The first part of this section discusses the role of socio-economic determinants as underlying causes of malnutrition (A). The second part underlines how malnutrition can perpetuate the existence of socio-economic inequalities (B).

1.1. Malnutrition: a socio-economic reality inscribed in bodies and minds.

The socio-economic environment in which individuals live profoundly impacts their nutritional outcomes beyond their biological predispositions (Thompson, 2014). For this reason, malnutrition, which lies at the intersection of biological and social factors, is a popular research topic for health economists. In the Appendix, Figure A0.1 illustrates how this socio-economic influence operates on the emergence of malnutrition issues through a wide array of determinants. These determinants of malnutrition can be divided into two main categories: microeconomic factors (different resources available to individuals and patterns of consumption adopted) and macroeconomic factors (including the role of governance, prevailing socio-cultural norms and the international economic context).

At the microeconomic level, the distribution of malnutrition risk is highly unequal across the population. In cases where food availability is the main issue, the cost of healthier foods is a barrier, leading to consuming products of lower nutritional quality (Darmon & Drewnowski, 2015). As a result, the poorest segments of the population are at higher risk of adopting unhealthy eating behaviors, such as lower consumption of fruits, vegetables, whole grains, and pulses, while increasing their consumption of fatty, salty, and sugary products (Julia et al., 2021). However, income effects alone do not fully explain the malnutrition equation. For instance, education can enhance individuals' nutritional knowledge and enable them to make better food choices even with a limited budget (Caillavet et al., 2014). Therefore, it seems more relevant to examine the whole individual's socio-economic status (SES), including the effects of income, education and occupation on malnutrition. To support this remark, a study in urban China found no significant differences in obesity prevalence between the wealthiest and poorest households (Bonfond & Clément, 2014). However, when the relationship between obesity and social class (based on SES) was examined, the results showed that people from the new middle class (young and educated managers and employees) were less susceptible to obesity-

related problems. Even more, the authors have proposed an extension of their study, exploring the relationship between knowledge and food preferences across different social classes in China (Clement & Bonnefond, 2015). On this question, their findings highlighted that women, the elderly and the new middle class showed greater sensitivity to returning to natural food consumption and adopting healthier eating habits. To conclude, this approach based on the SES seems relevant as behavior and nutritional outcomes depend on various multidimensional aspects of individuals' socio-economic positions within society. That is why this approach is widely used in health economics studies (*e.g.*, Baum II & Ruhm, 2009; Murasko, 2009; Van de Poel et al., 2008). Nevertheless, dietary behavior is also influenced by broader socio-economic factors at the national and international levels, as we will explore further below.

At the macroeconomic level, the emergence of malnutrition issues is influenced in different ways by countries' economic and social development. More precisely, the concept of "nutrition transition" by Barry Popkin (2011), depicted in Figure A0.2 in the Appendix, describes how each stage of the development process corresponds to a specific malnutrition situation. In a few words, rapid social, economic, and technological changes have progressively reduced undernutrition problems and led to dietary changes characterized by higher fat and lower carbohydrate diets (Popkin et al., 2001). These dietary shifts often manifest as increased consumption of processed and packaged foods, reflecting changing social statuses (James, 2008). Various globalization factors have contributed to these nutritional changes, including the role of industrialization, urbanization, the feminization of the labor force, and technological advancements. On the supply side, the decline in the cost of fats and sugars (particularly with the rise of supermarkets) has made processed and preserved foods more affordable than fresh foods (Drewnowski, 2003). On the demand side, changes have simultaneously occurred, with families becoming more dependent on markets as women produce less and buy more food for home consumption (Hansford, 2010). All of these changes are particularly visible in LMICs in full economic expansion, such as India, China, or Mexico, which are experiencing a significant increase in the number of overweight adults (*e.g.*, Q. Huang et al., 2020; Nguyen et al., 2021; Ponce Alcalá, 2020). Unfortunately, this overweight/obesity increase followed a prolonged period of food shortages that have not yet been fully resolved. As a result, particular attention must be paid to developing countries, especially low-income populations in LMICs, as they face a combination of these two forms of malnutrition as they move towards middle-income status. Besides, particular attention must be given to the concept of gender as the nutrition transition process have a greater impact on women's nutritional status than on men (Hansford,

2010). For instance, in Brazil, the nutritional status of women changed dramatically between 1975 and 1997 (Monteiro et al., 2004). In 1975, there were two cases of undernourishment for every case of women overweight in Brazil, but by 1997, there were more than two cases of overweight for every case of undernourishment. In this regard, women of LMICs particularly live this "double burden" of malnutrition associated with the persistence of cultural rules restricting women's engagement in leisure-time sports and physical activities (*i.e.*, Hansford, 2010) combined with the obesogenic environment created by the process of nutritional transition.

In addition, the study of the determinants of malnutrition requires an understanding of the links between the SES of individuals and the level of economic development of countries. The first landmark study on this topic showed a positive association between household SES and obesity in LMICs (valid for men, women and children) (Sobal & Stunkard, 1989). One potential explanation is that in these countries, household SES is primarily related to asset ownership and income, thus positively associated with obesity in all populations. Conversely, Sobal and Stunkard (1989) also showed that this SES-obesity association is negative for women and inconsistent for men and children in developed countries. The last finding can be explained by the fact that, in these countries, household SES may be more related to opportunity structures related to education and employment. For men, the inconsistent associations may reflect opposing effects of different components of SES on diet, with income having a positive effect and education having a negative effect. For women, education and the paid labor market have become increasingly accessible and seem to contribute to better nutritional outcomes. To conclude, the combined effects of the socio-economic position of individuals and the national context lead to different nutritional outcomes, which interestingly differ according to gender.

More interestingly, one study has proposed to divide countries' levels of economic development into three subsamples (countries of low, medium and high human development index) to understand better this reversal of the SES-obesity gradient observed among women (McLaren, 2007). First, the results confirmed previous findings by showing that the proportion of negative associations related to obesity increased with the economic development of countries. Second, the study also highlighted that the negative associations between SES and obesity among women were less common than previously thought, possibly because of the pressures of the obesogenic environment on women, which, in some contexts, prevent them from adopting positive behaviors. More generally, many other studies have confirmed the finding of a reversal

of the SES-obesity gradient, occurring earlier for women than men, in line with economic development (*e.g.*, Daran et al., 2023; Dinsa et al., 2012; Monteiro et al., 2004; Pampel et al., 2012). Among the main determinants not mentioned above, Pampel et al. (2012) highlighted the importance of changing cultural norms as a critical determinant of the ongoing dietary transition. To better explain this finding, it should be noted that in low-income countries, low SES is associated with deprivation and dietary restrictions. In contrast, higher SES means independence from physically demanding work and access to more food. Previous facts help to explain why curvy body shapes are often admired as a sign of high status in these countries, especially for women wishing to demonstrate the success of their financial family prosperity. Conversely, in higher-income countries, being overweight can be perceived as a cost (both health and economic), and wealth allows access to healthier food and regular exercise. Thus, in these countries, women who wish to achieve a high SES will, therefore, seek thinness as a socially valued attribute, synonymous with a certain quality of life in a resource-rich society.

In light of previous literature findings, we can conclude that food reflects social realities ingrained in consciousness, which subsequently manifests in physical outcomes (Fournier et al., 2015). Further research should, therefore, consider cultural norms and ideals as pivotal factors in shaping modifications in dietary practices. These determinants appear crucial in elucidating ongoing nutritional shifts, especially in women's diets. This observation holds significant interest if we aspire to achieve favorable changes in nutrition in the future. Moreover, it serves as a guiding principle for research to explore the factors influencing malnutrition comprehensively.

1.2. Malnutrition: a biological reality with socio-economic consequences.

As explained in the previous section, the human body and its appearance internalize a "habitus" in Bourdieu's sense (Bourdieu, 1972), reflecting individuals' socio-economic circumstances, group or community affiliations, and the sociocultural norms of their societies. More precisely, the differentiated food consumption practices between individuals and the sexual division of labor gradually lead to different physical appearances (Fournier et al., 2015), becoming part of their genetic makeup, similar to natural selection (Touraille, 2014). From this perspective, food consumption choices create inequalities between and even within societies, exacerbating socio-economic inequalities between people (De Garine, 1988).

At the individual level, malnutrition has significant biological consequences that limit people's ability to choose the life they want to lead. For more information about that, the concept of limitations is well-described by Sen's "capabilities" theory (Sen, 1982). This lifestyle limitation begins at the beginning of life, according to Barker's hypothesis (Barker et al., 2005), as fetal growth and size abnormalities increase the risk of later pathological disorders (De Boo & Harding, 2006). For instance, inadequate fetal growth during the first two years of childhood can result in stunted growth (shorter height) and have long-term effects in adulthood, such as lower educational attainment and reduced earning potential (Victora et al., 2008). Hence, from a health perspective, Grey et al. (2021) conducted a comprehensive review that outlined various health disorders resulting from childhood malnutrition or famine. These health issues include an increased risk of cardiovascular disease (reported in 7 out of 8 studies), hypertension (reported in 8 out of 11 studies), impaired glucose metabolism (reported in 15 out of 24 studies), and metabolic syndrome (reported in all 6 studies) in later life. Similarly, Bellver & Mariani (2019) highlighted the elevated risk of health problems in children when parents, particularly mothers, are overweight, especially if the mother was obese before pregnancy and gained excessive weight during it. These health issues encompass metabolic conditions like obesity, type 2 diabetes, cardiovascular disease, metabolic syndrome, and non-metabolic diseases such as cancer, osteoporosis, asthma, and neurological disorders. As a last example in line with these findings, the literature has shown that exposure to hunger during in-utero and early postnatal stages could potentially lead to adult mental illness (C. Huang et al., 2013). Unfortunately, all these health disparities significantly affect human capital development in later life. To support this finding from an economic perspective, Galler et al. (2012) conducted a comprehensive study on childhood malnutrition, specifically protein-energy malnutrition, following a cohort of individuals for 40 years. The findings revealed that even a single episode of severe childhood malnutrition, if later corrected through effective rehabilitation, was associated with lower social status in adulthood, especially in terms of education and employment. Among the key factors contributing to these adverse outcomes, cognitive impairment plays a significant role in explaining income disparities between individuals who experienced childhood malnutrition and those with a healthy childhood. To conclude, Palloni et al. (2009) underscore that early childhood health is one of the determinants of adult SES and contributes to the socio-economic gradient in adult health and mortality. This discovery enriches our understanding of SES inequalities and the disparities in adult health outcomes.

Among the major inequalities in malnutrition, women are the most affected, accounting for about 60% of the world's undernourished population¹⁸. One factor of the existence of such disparity is gendered social norms that exacerbate food deprivation. Traditionally, women take on the responsibility of feeding the household and often prioritize ensuring their family members eat first. As such, in the context of scarce food resources, men, perceived as stronger, tend to receive preferential treatment, leaving women with less nutritious options that fail to meet their daily nutritional requirements. Several other factors increase women's vulnerability to undernutrition, including the trauma of physical or sexual violence, which can lead to a loss of appetite associated with depression. Besides, restrictive local norms for women, such as bans on eating in the presence of men or isolation during menstruation, also compound the issue, sometimes extending to bans on women cooking for themselves. Unfortunately, these gender differences in access to various types and qualities of food (mainly due to intra-household dynamics) can lead to biological disparities between males and females (Hansford, 2010). By affecting women's physical and mental well-being, it makes them more susceptible to disease and mortality. As a result, it is crucial to address malnutrition, especially for women, as it perpetuates socio-economic inequalities that already disproportionately affect them. Investing in preventing maternal malnutrition is also more generally critical for achieving better long-term outcomes that will benefit future generations. One of the first concrete illustrations of the positive impact of such interventions can be seen in Panama's nutrition programs implemented between 1969 and 1977. These initiatives targeted pregnant women and young children, significantly enhancing adult human capital. These improvements included increased height, higher levels of education, improved economic productivity, and higher wages (Martorell et al., 2010). Numerous other studies in the literature also detail interventions addressing malnutrition in women. These interventions include education (Mistry et al., 2019), supplementation (Haider & Bhutta, 2017), and community-based programs (Menon et al., 2016). Overall, all these interventions have positively affected women's dietary practices, nutritional status, and well-being. Maternal nutrition education and counseling, as seen in Bangladesh, have significantly improved dietary diversity and micronutrient intake among pregnant women. Iron and folate supplementation during pregnancy, as demonstrated by Haider & Bhutta (2017), have effectively reduced the prevalence of anemia. Finally, as Menon et al. (2016) outlined, community-based nutrition programs implemented in India have contributed to reducing

¹⁸ [Gender and hunger: Why are women more affected by undernutrition? \(actioncontrelafaim.org\)](https://www.actioncontrelafaim.org/en/gender-and-hunger-why-are-women-more-affected-by-undernutrition/) (accessed on: 10/10/2023).

anemia prevalence and enhancing dietary diversity among women.

At the level of countries, research underscores the critical importance of enhancing population health through positive changes in dietary habits. Improving health through better nutrition can increase labor efficiency through metabolic energy and ultimately drive economic growth (Strauss & Thomas, 1998). To illustrate this point, previous authors reference the case of the British economy from the 1980s to 2000, suggesting that approximately 30% of the country's economic expansion can be attributed to general dietary enhancements. Similarly, more recent research by Abdul Manap and Ismail (2019) emphasizes the significance of food security in improving various aspects, including life expectancy, overall employment rates, and poverty reduction, ultimately promoting economic growth in dry-land developing countries. Conversely, when a country fails to invest adequately in nutrition, negative consequences can manifest, as seen in the case of China. Now, the segment of China's population that endured famine between 1959 and 1961, particularly those born in 1959, exhibits growth retardation of approximately 3.03 cm compared to their non-famine-exposed counterparts (Y. Chen & Zhou, 2007). These population-level differences in adult height have long-term implications for their quality of life (Fogel, 1994). Precisely, in the case of China, existing literature highlights that the famine significantly and negatively impacted the labor supply and income of survivors who experienced famine during childhood (Y. Chen & Zhou, 2007). More broadly, authors such as Siddiqui et al. (2020) or Hawkes et al. (2020) provide evidence of the crucial relationship between nutritional status, human capital, and economic well-being. It is clear from previous research that malnutrition adversely affects both physiological and mental capacities, thereby reducing productivity levels and making individuals and their respective countries more susceptible to poverty. Consequently, a two-way link exists between malnutrition and poverty, creating a vicious cycle in which each factor exacerbates the other. Malnutrition contributes to conditions of poverty by diminishing the economic potential of the population, while poverty reinforces malnutrition by increasing the risk of food insecurity.

While previous conclusions primarily focused on issues of undernutrition, they are equally applicable to contemporary challenges associated with overnutrition. In the USA, for instance, Renna & Thakur (2010) conducted a study examining older working-age adults. Their research revealed that obesity classes 2 and 3 are linked to increased rates of early retirement and disability, particularly affecting women more significantly. There was a 1.5% increase for men, while for women, the increase was 2.5% for early retirement and 1.7% for disability. More

recently and always in the USA, a study conducted by Segal et al. (2021) analyzed the impact of childhood overweight and obesity on human capital development, specifically focusing on cognitive performance, educational attainment, and wages. The study highlighted the detrimental effects of overweight and obesity, particularly on children's educational attainment, with a more pronounced negative impact on girls than boys. However, we must notice that these trends are not unique to the USA. Similar findings have emerged in South Africa, where Henry and Kollamparambil (2017) emphasized the emergence of obesity-related costs in the adult labor market. These results indicate that obesity is recognized as a contributing factor to labor market discrimination and disproportionately affects women's economic integration. Greve (2008) has also explored the relationship between BMI and employment status and wages in Denmark. The findings of this study revealed a negative BMI effect on employment for women and an inverted U-shaped effect for men (but only in the private sector). More generally, these findings are consistent with a comprehensive study encompassing Western societies conducted by Reiband et al. (2020). In investigated countries, this study confirmed the negative effects of obesity on adult wages and employment, with a more significant impact on women. Key determinants of these adverse effects included low educational attainment, poor health, and limited development of cognitive and non-cognitive skills.

In summary, malnutrition reflects the socio-economic situation of individuals, often affecting the most disadvantaged groups and creating a cycle in which poverty and malnutrition are mutually reinforcing. In the previous section, we have shown that poverty is an important factor, but the socio-economic status of households, including wealth, education and occupation, also plays an essential role in the emergence of various malnutrition problems. We also pointed out the importance of broader economic factors such as urbanization, globalization, increased female labor force participation, and cultural changes, which influence people's diets and collectively affect their well-being. Finally, we mentioned that malnutrition could exacerbate socio-economic inequalities, affecting people's health, economic prospects and life chances in general. Thus, malnutrition inequalities contribute to differences in human capital and economic progress between individuals and countries. Interestingly, the Millennium Development Goals prioritize interventions targeting women to break the cycle of intergenerational poverty, malnutrition and poor health; these women face double malnutrition due to increased nutritional needs during pregnancy and lactation, exacerbated by gender (H. F. Delisle, 2008). This approach is based on the fact that women respond differently from children and men to cultural and social changes induced by economic development, which can

lead to positive nutritional changes. However, it is important to note that ongoing dietary changes related to the situation of women can also have potentially detrimental effects on the objectives of fighting malnutrition. The following section, therefore, will underscore the importance of women in nutrition and the need for more gender-specific research on experiences of malnutrition in relation to mobilizing the female lever.

2. Socio-economic inequalities in malnutrition: women's role and promotion of the empowerment concept.

In the first part of this section, we show how women's empowerment is emerging as a critical factor for improving populations' health and nutritional status (A). In the second part, we identify different channels through which women can contribute to addressing nutrition challenges (B). The final part discusses the limitations and difficulties of implementing women's empowerment policies, particularly regarding their potential adverse effects (C).

2.1. Women's empowerment for better nutritional results?

Numerous studies have emphasized the divergent preferences between men and women regarding household resource allocation. Generally, mothers who assume the primary caregiving role within households are more likely to influence their family's health and nutrition positively. However, the distribution of these resources varies depending on the relative power dynamics among household members (*e.g.*, Hoddinott & Haddad, 1995; Quisumbing, 2003; Quisumbing & Maluccio, 2003; Udry et al., 1995). Consequently, promoting women's empowerment has emerged as a crucial aspect of public policies fighting malnutrition and has received support from major international organizations (*e.g.*, FAO, 2011; Smith et al., 2003). Empowerment holds significant importance from an equity and social justice standpoint, making it an end for women's well-being before a means to achieve other objectives. Besides, women's empowerment is inseparable from other development goals, such as poverty reduction and the promotion of human capital, particularly in areas such as nutrition, health, and education (*e.g.*, World Bank, 2001, p. 200; Yoong et al., 2012).

Understanding the potential impact of women's empowerment on nutrition first requires a better understanding of the concept. On the subject, it is important to recognize how the definition of the concept of women's empowerment widely varies depending on the author and context (Sen,

2001). Based on the most widely accepted definition, women's empowerment can be expressed as "the expansion of people's ability to make strategic life choices in a context where this ability was previously denied to them" (Kabeer, 1999, p. 437). This definition tends to achieve unanimity for the two distinct elements it presents. First, it emphasizes a notion of process, meaning the transition from a state of powerlessness to a certain level of autonomy. Second, this definition of women's empowerment is closely linked to the concept of "agency"¹⁹, which denotes a situation where women are the primary catalysts of transformations that affect them. More broadly, women's empowerment is often associated with notions such as choices, power, options, opportunities for control, or "agency." To assess women's empowerment, particularly in the context of malnutrition, numerous studies utilize proxy measures as part of their methodology. When establishing a direct link between empowerment and nutrition is challenging, researchers often use indirect measures associated with empowerment (Malhotra et al., 2002). To rapidly summarize them, these measures include women's educational attainment, workforce participation, legal protections in their favor, various aspects related to kinship and marriage, ownership of assets like land, social norms, and women's political representation. Besides, the literature also attempts to identify more direct measures of women's empowerment, namely, for the well-known: decision-making power within the household, access to and control over resources, freedom of movement, power dynamics between men and women, attitudes towards domestic violence, and access to specific resources like education, paid employment, or exposure to mass media (*e.g.*, Arulampalam et al., 2016; Bhagowalia et al., 2012; Fafchamps et al., 2009; Guha-Khasnobis & Hazarika, 2006; Shroff et al., 2011).

In the Appendix, Figure A0.3 depicts how women's empowerment can increase access to food and healthcare, which may significantly improve their well-being and that of their children. In Pakistan, for instance, advancements in women's status within households are positively associated with improved child food security (Guha-Khasnobis & Hazarika, 2006). Similarly, in Bangladesh, increased levels of women's education, indicative of heightened autonomy, are linked to higher dietary diversity scores and reduced rates of child stunting (Bhagowalia et al., 2012). In India (Andra Pradesh), maternal autonomy has been associated with better infant feeding practices and growth outcomes (Shroff et al., 2011). As a last example, in Ethiopia, increased levels of women's education, indicative of heightened autonomy, are linked to higher

¹⁹ According to Amartya Sen, "agency" refers to a situation where "a person is free to do and achieve in pursuit of whatever goals or values he or she regards as important" (Sen, 2001).

dietary diversity scores and reduced rates of child stunting (Fafchamps et al., 2009). Many other studies have reported the same findings in different contexts, highlighting the importance of women's empowerment policies as a key factor in the fight against malnutrition (*e.g.*, Cunningham et al., 2015; Kazianga et al., 2009; Malapit et al., 2015; Santoso et al., 2019; Shafiq et al., 2019; Van den Bold et al., 2013). In opposition, the literature shows that the absence or low level of women's empowerment harms women and their children (*e.g.*, Bhagowalia et al., 2012; Quisumbing, 2003). The experience of domestic violence, a significant indicator of autonomy deprivation, is linked to various adverse nutritional outcomes (*e.g.*, Murray et al., 2020; Yount et al., 2011), such as child malnutrition in Liberia (*e.g.*, Sobkoviak et al., 2012), Bangladesh (*e.g.*, Lentz, 2018; Ziaei et al., 2014), India (*e.g.*, Ackerson & Subramanian, 2008; Sethuraman et al., 2006) or Vietnam (Bui et al., 2018). This lack of women's empowerment also contributes to higher under-five mortality rates in Nicaragua (Åsling-Monemi et al., 2003) and reduces the likelihood of receiving prenatal care, vaccinations, and breastfeeding in Latin America (Dávalos & Santos, 2006). Overall, these low levels of women's empowerment negatively affect nutrition through multiple channels, including low self-confidence, compromised mental health, time constraints, stressful environments, limited control over household resources, and access to health information (Bhagowalia et al., 2012). As such, mothers play an indispensable role and can influence the nutritional outcomes of their families through multiple mechanisms, as illustrated below.

2.2. Women's role in nutrition.

This section underscores the significant role women play in shaping their children's nutritional outcomes, with their influence being both indirect and direct. In terms of indirect influence, it commences with women's nutritional status before and during pregnancy, which subsequently impacts their children's nutrition. For instance, in India, a study revealed a higher incidence of low birth weight among infants born to underweight and anemic mothers who did not receive antenatal care (Dubey & Nath, 2016). Similarly, postpartum assessments conducted in Argentina demonstrated a positive correlation between newborns' fat mass and maternal obesity or excessive weight gain during pregnancy (Pacce et al., 2016). Conversely, women also exert a direct influence on their children's nutrition from an early age by providing food, which encompasses activities such as breastfeeding, ensuring a diverse diet, and ensuring adequate food quantities.

First, we should mention that the role of women in nutrition is pivotal and complex, as it can either mitigate or exacerbate gender disparities in malnutrition. On the one hand, various studies have underscored that boys may face a higher risk of nutritional issues at birth compared to girls, with exceptions in South Asia (Saville et al., 2022; Thurstans et al., 2020, 2022). In contexts of nutritional deprivation, these studies explain that pregnant mothers expecting boys are more affected due to the higher energy requirements of boys. Consequently, girls are born with a developmental advantage of 4 to 5 weeks, necessitating compensatory measures during early life stages. By allowing gender disparities in food allocation, mothers could potentially narrow this developmental gap by up to 12 months, as boys tend to catch up more quickly with girls during the period of introducing complementary feeding. On the other hand, other forms of gender-based disparities in food distribution, motivated by other goals, can perpetuate the existence of these gender disparities. In Cameroon, for instance, research by Manirakiza et al. (2015) illustrates how food restrictions imposed on women, particularly related to chicken gizzard consumption, reinforce gender norms and uphold masculine dominance within societal structures. Otherwise, in India, previously justified gender disparities aiming to counteract biological differences persist during childhood and adolescence (Aurino, 2017), with another motivation based on varying educational aspirations between girls and boys (Coffey, 2015). However, Aurino (2017) reveals that such gender disparities lead boys to consistently enjoy better nutrition in India, except within the 12-year-old age group, and this gap widens at the age of 15. Consequently, adolescent girls at this stage are less likely to consume protein- and vitamin-rich foods like eggs, legumes, fruits, and root vegetables. In conclusion, women's influence on nutrition is a double-edged sword that shapes food distribution patterns and may either address or exacerbate gender disparities in malnutrition. Therefore, understanding and addressing the complexities of their role is essential for promoting better nutrition outcomes for all.

Second, women assume a crucial role in nutritional education, enabling positive dietary transformations. This willingness to acquire new nutritional knowledge is evident even in disadvantaged regions like Sri Lanka (Weerasekara et al., 2020). As demonstrated by a randomized controlled trial in Lima (Penny et al., 2005), the nutritional knowledge they acquire is essential to fight malnutrition. In Lima, the program aimed to provide education and nutritional guidance to mothers during pregnancy and up to 13 months postpartum. In brief, this initiative effectively addressed issues like child growth retardation, reduced prematurity and low birth weight, particularly among boys. Similar successful experiences have been reported

in other contexts, including Burkina Faso (Nikièma et al., 2017), Bangladesh (Mistry et al., 2019), China (Shi et al., 2010), and Pakistan (Zaman et al., 2008). Nonetheless, while the importance of maternal education is undeniable, it may not, on its own, lead to statistically and physiologically significant outcomes (H. Delisle, 2021). To achieve the desired results, interventions should also address the economic accessibility of nutritious food, as neglecting this aspect can impede progress. For instance, in Ghana, a promising strategy involves developing the agricultural sector, a crucial component for achieving food security (Marquis et al., 2018). In higher-income countries, the challenges faced by women take on a different dimension. For example, a study in Australia sought to understand how working mothers who bear household responsibilities and contribute to their family's food supply can adhere to national nutrition recommendations (Mehta et al., 2020). The study, conducted through semi-structured interviews, revealed a certain disconnect between the realities experienced by women, including time constraints and daily stress, and the national guidelines, despite their nutritional knowledge. Hence, well-educated women strive to balance their roles as mothers and their integration into the labor market, a complex task that requires consideration of the available time. Therefore, personalized nutritional education advice should be tailored to individuals' economic, social, and cultural circumstances to account for the local challenges people may face (Nikièma et al., 2017).

Finally, it is imperative to consider the multifaceted dynamics of mothers' involvement in meal preparation and how it impacts overall family nutrition. Historically, women have borne the responsibility of selecting and preparing nutritious meals for their families, aligning with the dietary needs of their loved ones. However, translating this ideal into practice necessitates a keen understanding of their specific living conditions and the opportunities accessible to them within their environment. In developing countries, meal preparation practices evolve, with urban women encountering distinct challenges compared to their rural counterparts. For instance, in Latin America, Biermayr-Jenzano (2019) illustrates that urban women, unlike their rural peers, may not engage in agriculture, face time constraints due to wage-earning responsibilities, and confront limited access to healthy but more affordable and convenient food options. This issue is even more pronounced in developed nations, such as Singapore, where mothers' active participation in the labor market often leads to a preference for purchasing fresh food from outside rather than preparing meals at home (Wang et al., 2014). Similar situations have been observed in places like Cyprus (Minas et al., 2013) and Taiwan (Y.-S. Chen et al., 2016). In these cases, readily available and affordable unhealthy processed foods have become

prevalent, contributing to children's frequent consumption of restaurant meals and influencing their dietary choices. Within this context, mothers face the challenge of monitoring their children's exposure to unhealthy foods and guiding them toward healthier options. For instance, a study in Australia found that children of part-time working mothers were less likely to be overweight or spend excessive time watching television compared to those of full-time working mothers (Brown et al., 2010). This difference might be attributed to part-time mothers having more time and energy to invest in healthier habits. Several studies have underscored a positive connection between maternal employment and a higher child body mass index (Anderson et al., 2003; Chia, 2008; Morrissey et al., 2011; Phipps et al., 2006; Ruhm, 2008). One potential strategy to address this challenge is to involve other family members, like grandparents or domestic workers, in meal preparation to ensure the provision of healthy meals. For instance, in Cyprus, older household members often contribute to home cooking (Jacobson et al., 2010). In conclusion, understanding the intricate interplay between cultural norms, economic factors, and available opportunities is vital in shaping the role of mothers in meal preparation, which, in turn, profoundly influences family nutritional outcomes.

2.3. New challenges of "Empowerment-lite."

Although we have already mentioned all the benefits that policies promoting women's empowerment can have, some authors argue that women's empowerment may not align with the original objectives of emancipatory efforts for women. Among these authors, Bacqué & Biewener (2015) point to the ambivalence surrounding the concept of women's empowerment. They argue that while women's empowerment is promoted as a response to women's original aspirations, this process can sometimes work against them. Among the arguments put forward are the strengthening of market-driven values that prioritize economic success over social justice and the potential fragmentation of solidarity among women, leading to competition for limited resources and opportunities. In light of this debate, it is relevant for us to examine the evolving role of women in the contemporary world and the nutritional issues involved.

In short, other authors like Cornwall & Brock (2005) have noted that women's empowerment is one of those vague, resolutely optimistic and fair concepts that, like poverty eradication, is bound to win consensus. However, the terminological ambiguity of the concept has led many authors to question its role in improving the economic well-being and living standards of people in low-income or developing countries when it has become a tool in the fight against poverty

(e.g., Cornwall et al., 2007, 2008; Cornwall & Edwards, 2010; Molyneux, 2006). Empowerment has gradually been co-opted from a concept of development serving people in poverty to one of the poor serving development (Wong, 2003). Cornwall (2018) refers to this phenomenon as "empowerment-lite." One of the main criticisms is that empowerment has been individualized and depoliticized, reduced in practice to its economic dimension, while ignoring the psychological and social dimensions of power involved (Wong, 2003). A notable example is the promotion of microcredit as a tool for women's empowerment, despite research showing that women are often pressured to repay these loans (Guérin & Kumar, 2020; Reboul et al., 2021). In the same way, Falquet (2008) discusses the changing role of women as they move from a "care" economy in the family and private sphere to a "care" economy in the economic and public sphere (care, housework, childcare, etc.). The author claims that globalization creates and reinforces gender inequalities by exploiting women, particularly in sectors such as agriculture, the textile industry, and low-paid, precarious jobs in the service sector.

In broad terms, women's empowerment policies being promoted aim to enhance the status of mothers and women by offering improved employment and education opportunities. The objective is to grant them more significant influence within their households and enable more effective negotiation with their husbands to meet family needs. Yet, questions arise regarding the compatibility of these roles as women join the labor market while managing traditional domestic responsibilities (Cornwall, 2018). As women are increasingly expected to contribute to economic growth by participating in expanding consumer markets, they also grapple with their unpaid social reproductive roles. Therefore, public policies should focus on reshaping gender dynamics both inside and outside the home, considering the additional workload placed on women and its implications for the health and nutrition of the population. For instance, a macroeconomic study found that women's empowerment consistently predicts an increase in average body mass index (BMI) in countries over time (Fox et al., 2019). Another example is decisions about breastfeeding, which reflect the contemporary context of women's circumstances. According to Volk & Franklin (2020), women always made a trade-off between "quantity" (*i.e.*, the number of offspring a woman can raise) and "quality" (*i.e.*, the ability to compete and reproduce those offspring as adults). Breastfeeding is part of this female intrasexual competition. In developing countries, wealthier women often choose not to breastfeed to differentiate themselves, showcasing their higher social status and ability to hold a job, afford formula, and expand their families. In developed countries, wealthier mothers, who have the resources for infant formula and better health, may have fewer children and

promote breastfeeding as a demonstration of their affluence. However, the ability to breastfeed is influenced by societal factors. Lack of social and financial support means that low-income mothers in affluent societies may prefer to breastfeed, but only the affluent can effectively signal their ability to do so. Consequently, as societies progress economically, breastfeeding, a natural and beneficial practice, responds to women's circumstances rather than a free choice accompanied by adequate support for themselves and their children (Volk & Franklin, 2020). These examples highlight how changes in women's societal roles can impact dietary choices and should be considered in scientific research, especially when addressing issues like malnutrition. That is why this literature on women's empowerment has sparked our interest in this thesis, particularly in the context of tackling malnutrition.

In summary, this section highlights how women's empowerment is critical to addressing malnutrition and improving health. We stress that women's empowerment can have positive effects, such as improving women's access to resources, decision-making capacity and overall well-being, leading to improved nutrition for women and their families. We also recognize that women's roles in nutrition are complex and can vary according to geographical and socio-economic factors. In particular, we raise concerns about the limitations and potential ineffectiveness of some women's empowerment interventions and emphasize the need for a comprehensive approach that addresses economic, social and cultural factors. We briefly discuss the concept of "empowerment lite," where some policies may not have substantial positive impacts or even have unintended negative consequences. In essence, the section highlights the multifaceted nature of women's empowerment and its critical role in addressing undernutrition and underscores its importance in research and policy considerations for achieving better nutrition outcomes.

3. Outline of the dissertation and contributions

The overarching theme of this dissertation is to address the persistent issues of socio-economic inequalities in malnutrition through gender-sensitive research. Our research objectives are intricately aligned with this theme, aiming to shed light on the complex relationships between gender, empowerment, socio-economic factors, and nutritional outcomes, ultimately offering valuable insights for shaping public health strategies and policies.

In Chapter 1, we disentangle the phenomena of women's socio-economic status and women's empowerment and identify what each contributes to child nutrition outcomes in Nepal. This research takes place in the context of the debate surrounding the concept of empowerment, which encompasses two distinct visions. One is the feminist approach, which seeks to promote women's power as a goal. The second, promoted by international organizations, aims to improve women's socio-economic status to fight against poverty. Our analyses are based on data from Nepal's Demographic and Health Survey for 2016. Using multiple component analyses, we construct an indicator of mothers' socio-economic status (including household wealth, level of education, and employment type) and an indicator of non-economic empowerment (non-acceptance of domestic violence, access to health, decision-making power and community support). The effects of these variables of interest are observed on children's height-for-age aged 6 to 59 months (Z-score) and the dietary diversity of those aged between 24 and 59 months (score on eight food groups). We run multivariate linear regressions and try to limit endogeneity bias through an instrumental variable strategy. Additionally, we analyze our results by sub-samples: age (over or under 24 months), place of residence (urban/rural) and gender (girls/boys) to account for heterogeneity. Our results highlight the importance of empowerment in terms of "powers" for better infant nutrition outcomes in Nepal. First, this form of empowerment also helps mitigate the adverse effects of low maternal socio-economic status. Second, the favorable impact of this empowerment is more significant among girls than boys, contributing to reducing gender bias in the country (son bias). We also point out that while promoting the improvement of women's socio-economic status, it is important to recognize that this can have mixed effects on child nutrition. While we view women's education as essential, we must also consider women's economic integration, particularly in the agricultural sector. This may lead to an increase in dietary diversity, but it is important to note that it could also have long-term negative effects on children's growth. In conclusion, we emphasize the benefits of empowering women in non-economic ways to fight undernutrition among young Nepalese children.

In Chapter 2, we test the existence of a reversal in the association between household wealth and optimal breastfeeding practices during the development process of Asian countries. To this end, we mobilize an ambitious database combining 42 Demographic and Health Surveys covering 15 Asian countries from 1990 to 2017. We construct four indicators of optimal breastfeeding practices (exclusivity, early initiation and continuity at one and two years of age) and a wealth indicator (based on household assets), enabling comparison between different

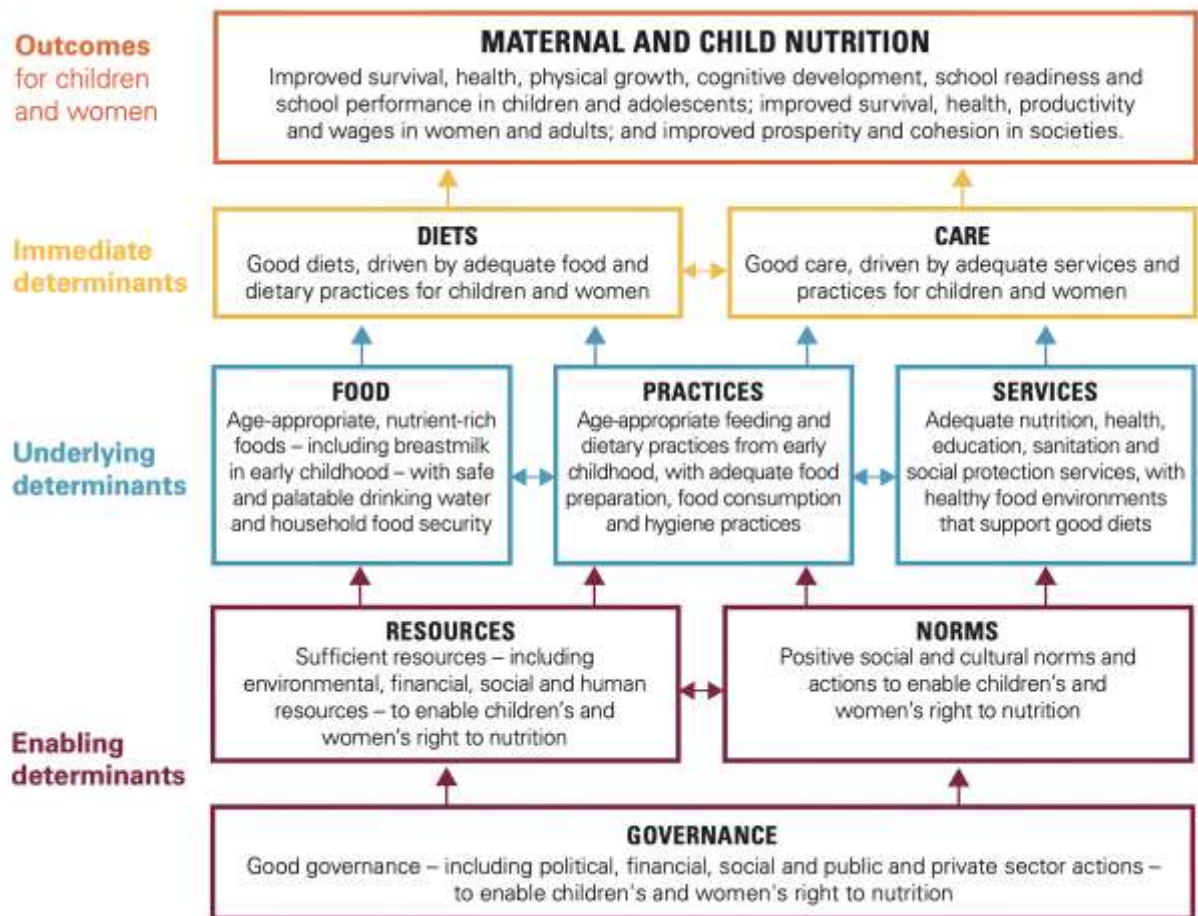
waves of surveys and countries. Econometrically, we analyze the wealth-breastfeeding association by incorporating interaction terms between household wealth and countries' level of economic development (low, medium and high) or time. We also attempt to address endogeneity issues through an instrumental variable approach. Our results confirm the presence of a transition in the wealth-breastfeeding gradient in Asia, especially regarding the exclusivity of the practice and its continuity. As a result of economic development, these traditionally pro-poor practices gradually extend to wealthier households. More specifically, while BF practices are pro-poor in the poorest countries, we show a decrease in the negativity of their relationship with household wealth along with economic development. Our results are specially marked for exclusive BF (with a complete reversal of the gradient) and confirm the transition's initiation for continued BF. However, early initiation of BF remains a pro-poor practice, though higher in the wealthiest countries. Our findings have important implications regarding targeting public policies to promote optimal BF practices. Given the observed shift in the wealth-BF gradient, interventions such as baby-friendly hospital initiatives, social safety nets, maternity leaves or restrictions on the formula market should focus more on the poor. The stakes are high since breastfeeding is one of the essential practices helping reduce socio-economic health inequalities.

In Chapter 3, we examine the impact of the transformation of gender-role attitudes on the adult gender obesity gap and the prevalence of obesity for each sex. We use a panel database constructed from WHO and World Bank data, covering 168 countries over 27 years (1990-2016). We measure gender attitudes in two ways: a) using the World Bank's Women Business and Law (WBL) index; b) using a broader multidimensional indicator constructed by principal component analysis combining three dimensions (the WBL index, fertility rate and women's labor market participation). Econometrically, we mobilize individual and time-fixed effects regressions and limit endogeneity bias through instrumental variable estimations. Our results show that when societies shift towards more progressive or feminist values, there is a temporary increase in the gender gap in obesity, which is unfavorable for women. In the long term, however, we expect this gender gap in obesity to narrow. Regarding the prevalence of obesity, we observe a complex relationship between gender and obesity rates. For men, obesity rates exhibit a U-shaped pattern, while women follow an inverted one. In other words, women tend to have higher obesity rates in societies with more conservative norms, while men tend to have higher rates in societies with more progressive norms. In short, narrowing the obesity gap between the sexes does not necessarily indicate progress in the fight against obesity.

Furthermore, while the obesity gap between the sexes is narrowing, the overall prevalence of obesity is increasing. This increase is mainly driven by rising obesity rates among men, while at the same time, greater gender equality is associated with declining obesity rates among women. These findings highlight the important role of gender attitudes in the nutritional transition process and the obesity epidemic.

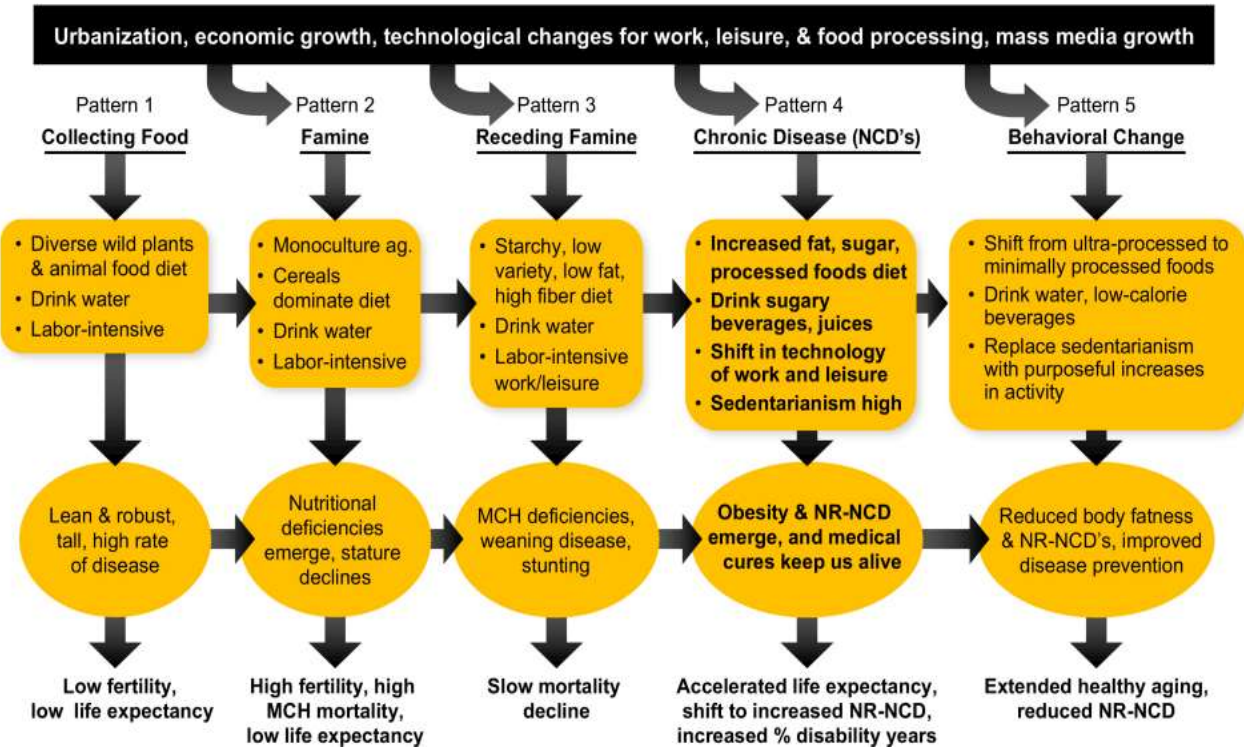
Appendix

Figure A0.1: A framework for preventing malnutrition in all its forms.



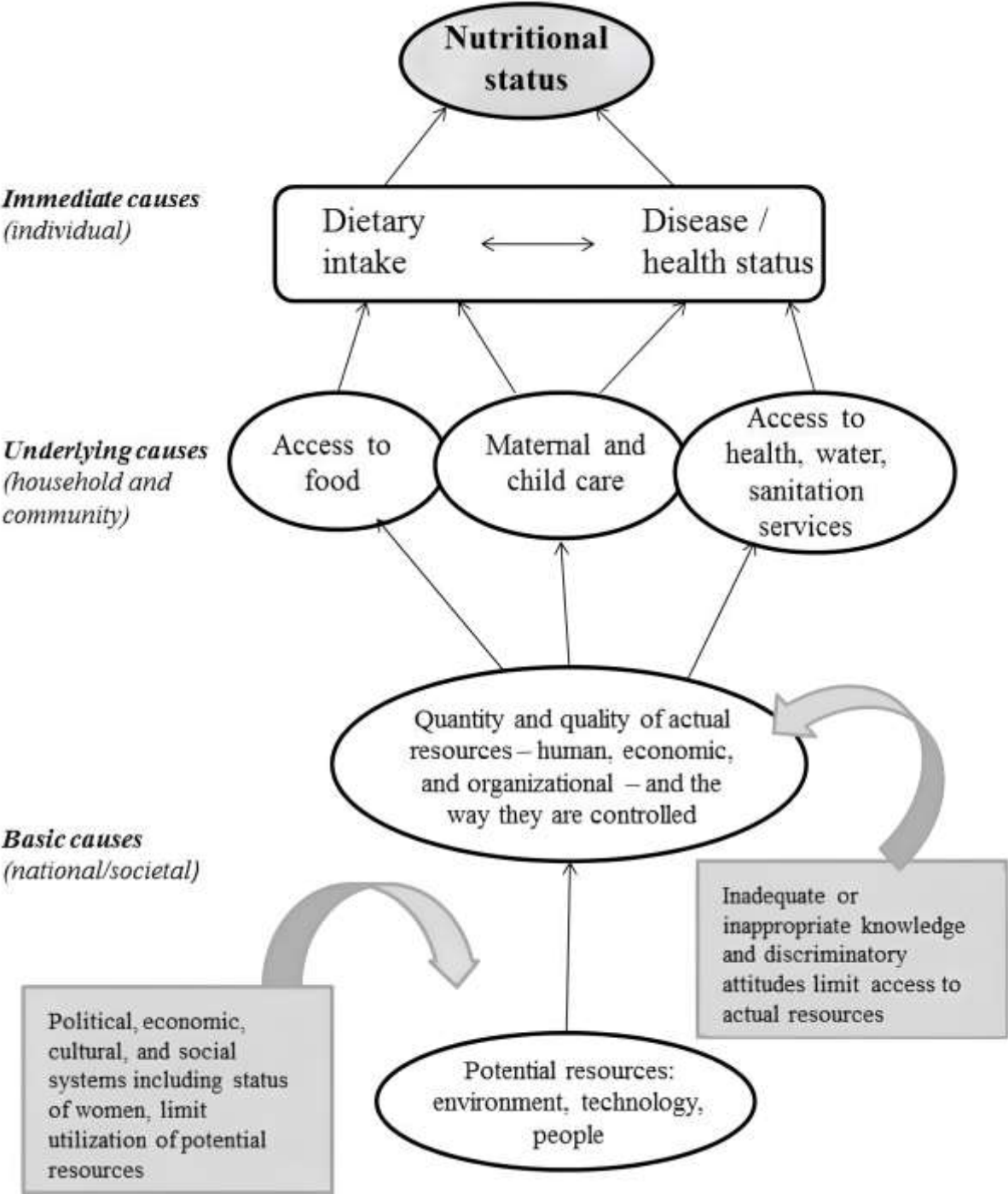
Source : (UNICEF, 2021).

Figure A0.2: Stages of the nutrition transition.



Source : (Popkin, 2021).

Figure A0.3: Conceptual framework depicting causes of malnutrition and links between women's empowerment and nutrition.



Source : (Van den Bold et al., 2013).

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Chapter 1: Child malnutrition in Nepal: Women's empowerment or promotion of their socio-economic status?

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Abstract:

After unsuccessful poverty alleviation policies to tackle the "Asian enigma," women's empowerment (WE) is now promoted as another strategy. However, the concept is still debated between pioneers defending more power for women and international institutions promoting it by improving their socio-economic status (SES). This paper proposes to advance this way by examining the impact of WE in terms of power on children's nutrition, also testing its interactive effects with the mothers' SES. Using the 2016 Nepal Demographic and Health Survey, we account for two measures of children's nutrition: height-for-age and dietary diversity scores. We use the multidimensional exploratory analysis to construct composite measures of WE and SES and tackle endogeneity issues through an instrumental variable approach. Our results demonstrate that the impact of WE is underestimated if endogeneity issues are not considered by potentially having a more positive effect on the fight against child malnutrition than women's SES promotion. Besides, interactive effects between WE and women's SES suggest that the positive relationship between WE and children's nutrition can mitigate the adverse effect of low maternal SES on children's growth in the long run. With regard to rural areas, the unclear results on women's SES encourage us to promote women's education but alert us to women's participation in the labor market and its mixed effects on maternal and child health. Finally, the promotion of WE seems crucial to addressing gender inequalities in child malnutrition at the local level.

Keywords: Child undernutrition; Women's empowerment; Nepal; Socio-economic status; Multiple correspondence analysis; Instrumental variables.

JEL classification: I14; I15.

1. Introduction

Undernutrition limits educational attainment, adult work productivity, and lifetime earnings potential, perpetuating financial losses and poverty (*e.g.*, Black et al., 2008). Unfortunately, the goal of ending hunger by 2030 is still a long way off. In 2020, between 720 and 811 million people worldwide were still undernourished, with more than half (418 million) living in Asia (World Health Organization, 2021). Better known as the "Asian enigma" (Ramalingaswami & al., 1997), Southern Asian countries have motivated considerable research on this issue.

The terminology "Asian enigma" appeared in the 1990s when the region had higher undernutrition levels than many Sub-Saharan African countries. Initially, anti-poverty measures were implemented to address this situation, but over time, researchers realized that the roots of the problem mainly lay in non-economic factors (Ramachandran, 2006). Indeed, in the region, mothers suffer from widespread poor mental and physical health, which Pennington et al. (2018) mainly explain by low levels of women's empowerment (WE). These women's lack of autonomy shreds of evidence of the existence of deep gender inequalities, which leads to poor health and nutritional outcomes, including low birth weight, child malnutrition and child mortality (Marphatia et al., 2016). Therefore, gender discrimination issues have progressively formed part of the literature on the determinants of child nutrition (*e.g.*, Fikree & Pasha, 2004). In this literature, numerous studies underscore the positive impact that WE may have on household production diversity (*e.g.*, H. J. Malapit et al., 2015), children's nutrition (*e.g.*, Allendorf, 2007), and mothers' nutrition (*e.g.*, Jones et al., 2020). Consistent with this literature, it appears that mothers are better at allocating economic resources than their partners for the benefit of their children, increasing the proportion of the budget spent on food and reducing the proportion spent on alcohol and cigarettes (*i.e.*, Hoddinott & Haddad, 1995). Nevertheless, the definition and measurement of WE is still debated, as demonstrated by many approaches that have been tested to link WE to children's nutrition (*e.g.*, Carlson et al., 2015; Cunningham et al., 2015). These facts explain why some authors have reached a more nuanced or even inconclusive empowerment-nutrition relationship (*e.g.*, Quisumbing et al., 2021; Santoso et al., 2019).

For a brief historical background, the concept of WE made its formal appearance in the 1980s with the work of feminists from the Global South who collectively formed the *Development*

Alternatives with Women for a New Era (DAWN) network founded in Bangalore in 1984²⁰. As Friedmann (1992) explains, the original idea was to see how development could reduce poverty by helping women to "strengthen or acquire power." However, this original vision was rapidly qualified as "radical" and did not receive much support (*i.e.*, Parpart, 2002) because of their criticisms that neoliberal, patriarchal, and neocolonial development models reinforced unequal power relations. It was not until the 1990s that the concept was promoted in a consensual way by the World Bank, making WE one of the pillars of the fight against poverty. However, for the precursors of the concept, this new vision of empowerment is unsatisfactory because it is more interested in how people experiencing poverty can contribute to development than how development can increase the power of the poor (*i.e.*, Wong, 2003). To further develop their opinion, the vision promoted by the Millennium Development Goals and the Sustainable Development Goals does not appear sufficient to capture how empowerment may influence women's lives and those close to them (Kabeer, 2005). For instance, one dimension of WE promoted through women's access to education can have limited effects if "women's role is purely defined in reproductive terms in the society, where education is seen in equipping girls to be better wives and women or increasing their chances of getting a suitable husband." The same is true when promoting WE through women's access to paid work, where many studies "highlight the exploitative conditions of work in which women are generally found" (*e.g.*, Falquet, 2008). Nevertheless, if the power and autonomy of women are crucial in ensuring the healthy nutritional status of their family members (Quisumbing et al., 1996), their action capacity also depends on their socio-economic conditions. The bi-directional and endogenous relationship between WE and poverty hence explains why empowerment is often reduced to its economic dimension while the psychological and social dimensions of power are ignored (Wong, 2003). Our research question is part of this context and tries to disentangle the effect of the power of women/mothers, according to these two visions (economic versus rather non-economic empowerment focus) in the fight against child malnutrition in Nepal.

For examining this research question, we chose Nepal since severe undernutrition issues still plague this society. Already, Nepal had one of the highest levels of undernutrition in the 1990s, with almost two-thirds of young children being stunted (Cunningham & al., 2017). In 2016, the final report of the Nepal Demographic and Health Survey (DHS) pointed out that 36% of

²⁰ A turning point in the history of the concept occurred in 1987 with the publication of *Development, Crises and Alternative Visions: Third World Women's Perspectives* (G. Sen & Grown, 1987).

children were still stunted and that 17% of mothers were considered thin. Regarding another issue, which is widespread anemia, 40% of women and 53% of children were also still affected. Nepal also appears to be a relevant case study about gender issues, as characterized by profound discrimination toward women. As such, Nepal was ranked 101st out of 144 on the Global Gender Gap Index in 2020, lagging in gender equality. Even more worrying, suicide is one of the leading causes of death for women of reproductive age, which illustrates Nepalese' feminine distress (Simkhada & al., 2015).

In this paper, we propose to use the 2016 Nepal DHS to analyze the relationship between WE (a non-economic measure inspired by the initial and "radical" concept of empowerment) and child malnutrition, testing the interactive effects with mothers' socio-economic status (SES) (a measure of WE more based on women's economic empowerment). In our opinion, this approach contributes to the literature in several ways. First, based on a theoretical framework (*i.e.*, Rowlands, 1997) supported by field experiences (*i.e.*, Lombardini et al., 2017), we propose to capture the concept of WE in an original way - in terms of different forms of *power* that allow to break down gender inequality barriers in women's daily lives - and to distinguish this version of WE from improvements in women's SES (as an expected outcome of the empowerment process). In doing so, we use the multidimensional exploratory analysis to position children in relation to their mother's level of empowerment (WE) and socio-economic conditions (SES). Second, we test the interactive effects between WE and women's SES on child malnutrition, which seems necessary to know the extent to which women's SES influences the relationship between WE and child nutrition, an approach that seems essential in designing effective policies and programs. Third, we provide a disaggregated analysis of the relationship between WE and SES on children's dietary diversity and height-for-age scores according to children's age, sex, and place of residence, which are important determinants of child malnutrition outcomes according to the literature. We finally address endogeneity issues to the extent possible through an instrumental variable strategy.

Our findings underscore that the relationship between WE in a so-called "radical" conception and child nutrition is underestimated if endogeneity issues are not taken into account and may have a greater impact on child malnutrition than women's empowerment policies that focus on improving women's SES. In a patriarchal society such as Nepal, rural populations and girls are particularly socio-economically disadvantaged. In this context, we show that increasing WE is

critical to reducing gender inequalities in child malnutrition, with WE having a stronger impact on girls' nutrition than on boys'. We tend to promote the need to increase mothers' SES in rural areas but are cautious about which dimensions of SES are essential for true local empowerment and better nutritional outcomes. Indeed, we insist on warning about women's participation in the labor market and its mixed effects on maternal and child health. Finally, the study of the interactive effects between WE and SES highlights a positive relationship between WE and child nutrition, which, in the long run, mitigates the detrimental correlation between low maternal SES and child growth (height-for-age).

The rest of the article is structured as follows. Section 2 describes the data and variables. Sections 3 and 4 present the econometric framework and the main results. Finally, Section 5 discusses the results, and Section 6 concludes.

2. Data and variables

This paper uses the 2016 Nepal DHS database, which provides a wide range of monitoring indicators in demography, health and nutrition at the national level. Initially, we use the dataset of children born in the last five years (0-59 months), namely data from 5038 children through their interviewed mothers aged 15-49. We then exclude children under six months for two main reasons. First, the exclusion of children under six months is common in nutrition surveys due to practical and technical difficulties in measuring newborns and young infants, as mentioned by Lopriore et al. (2007). Second, apart from children's height-for-age, we are interested in studying children's dietary diversification, *i.e.*, complementary feeding, which usually and optimally does not start before six months. Taking into account data restriction, we are ultimately able to analyze 2,151 mother-child pairs (children aged 6-59 months) for child anthropometry and 2,225 for dietary diversity. More information on the sample construction and selection can be found in Textbox A1.1 in the Appendix.

2.1. Women's empowerment (WE)

Among the many definitions of WE, Onah (2021) shares with us that all authors agree on its relational, complex and multidimensional aspects. Thus, we will retain the most influential definition of literature, which is "the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them" (Kabeer, 1999, p. 437). More in

detail, the empowerment process includes three steps: *resources* referring to pre-conditions or opportunity structures, *agency* which refers to the "freedom to achieve whatever the person, as a responsible agent, decides he or she should achieve" (A. Sen, 1985, p. 204), and *achievements* that are the realization of one's goals (Alsop & Heinsohn, 2005; Kabeer, 1999). Nevertheless, the consensus is more complex on the measurement, with many discussions on which domains and indicators are most relevant to analyzing its impact on children's nutrition (Ibrahim and Alkire, 2007). Indeed, researchers must be cautious as translating the concept of empowerment into a measure that captures it poses several challenges. One of the recommendations is that indirect indicators (*i.e.*, *resources* and *achievements*) can be problematic in measuring empowerment, especially with cross-sectional information (Richardson, 2018). As mentioned in our introduction, *resources/achievements* (such as education, land ownership, employment, age at first marriage, and participation in microcredit) can reflect women's *agency* but not ensure it (Kabeer, 1999, 2005). Furthermore, "the directionality of many of these relationships is unclear; these factors may be *resources* for empowerment, *achievements* of the empowerment process, or both" (Richardson, 2018). To overcome this problem, researchers generally use direct empowerment measures (*i.e.*, *agency*). Among the best-known attempts at measurement, we can cite the Women's Empowerment in Agriculture Index (WEAI) (Alkire, Malapit, et al., 2013), which is the most prominent direct and standardized measure for rural women in pastoral settings. We can also cite the Survey-based Women's Empowerment (SWPER) index, which more recently addresses the need for a nationally representative index that is easily usable for cross-country comparison (Ewerling et al., 2017, 2021). Generally speaking, these two examples illustrate a solid temptation for creating universal indices. However, authors like O'Hara & Clement (2018) argue that there are flaws in limiting empowerment measures to visible forms of action (like the WEAI index) and defend the relevance of including other forms of *power* like the *power from within* (Rowlands, 1997), also known as *critical consciousness* in Freire's (1974) research works.

In this paper, we strive to follow these recommendations, capturing the WE phenomenon based on the theory of *power* presented by Rowlands (1997), which can be expressed in four complementary dimensions: the *power from within*, the *power to*, the *power with*, and the *power over*. This old theoretical framework was adopted by some non-governmental organizations, such as OXFAM, which has created a guide for measuring WE using their field experience (*i.e.*, Lombardini et al., 2017). In our opinion, this approach is closer to the aspirations of so-called

"radical" feminists than the standardized approach (WEAI or SWPER). We, therefore, rely on these works and the empowerment module included in DHS since 1999 to stand, as much as possible, for each power previously exposed, as shown and discussed in Table 1.1 below.

Table 1.1: Components of our indicator of WE.

Dimensions	Survey questions	Modalities
<i>Power "with"</i>	(1) Is there a growth monitoring promotion group in the ward? (2) Is there a health mother's group in the ward?	No; Yes.
	<u>In your opinion, is a husband justified in hitting or beating his wife in the following situations:</u>	
<i>Power from "within"</i>	(1) If she goes without telling him? (2) If she neglects the children? (3) If she argues with him? (4) If she refuses to have sex with him? (5) If she burns the food?	No; Yes.
	<u>When you are sick and want to get medical advice or treatment, is each of the following a big problem or not a big problem:</u>	
<i>Power "to"</i>	(1) Getting permission to visit the doctor/health service provider? (2) Getting the money needed for advice or treatment? (3) The distance to the health facility? (4) Not wanting to go alone? (5) No female health provider?	Not a big problem; Big Problem.
	<u>Who usually decides about: you, you and your (husband/partner) jointly, or another person?</u>	
<i>Power "over"</i>	(1) Respondent's health care; (2) Making major household purchases; (3) Visit your family or relatives; (4) Children's education; (5) Using your husband's money.	Respondent alone; Respondent and her husband/partner; Husband/partner alone; Someone else; Other.

Note: We represent the four forms of power mentioned by Rowlands (1997) to construct our global and composite indicator of women's empowerment from a non-economic point of view on their abilities to realize themselves and to have daily power over control of their lives.

Source: Author's calculations.

The choice of variables made for each dimension of *power* is based on definitions made by Lombardini et al. (2017). First, the *power with* considers that empowerment is "a collective process requiring support and interaction between peers and organizations." In our work, we measure it by the presence (or not) of health mothers' groups (HMGs) and growth monitoring

promotion groups (GMP) in the ward. These groups empower mothers to provide appropriate child care (e.g., Gyampoh et al., 2014; Perry et al., 2017). Second, the *power from within* "looks at personal self-confidence as psychological strength," allowing individuals to influence their lives and propose changes. We measure it by the acceptability (or not) of gender-based violence (e.g., Sandberg & Rafail, 2013). Third, the *power to* "refers to individual agency, meaning their capacity to decide actions and carry them out." This power is attached to the personal sphere, and we measure it by barriers to women accessing health care (e.g., Htun et al., 2021). Finally, the *power over* measures "the strength of the strong over the weak, measuring power relationships between a woman and other individuals in the household or community where she lives." This power refers to the relational sphere, and we measured it by mothers' involvement in different household decision-making (e.g., Alkire, Meinzen-Dick, et al., 2013).

As described in Table 1.1, we combine the variables above presented in a Multiple Correspondence Analysis (MCA) in order to generate a more global and composite index of such different dimensions of *power*. In a few words, the MCA is a data analysis technique for nominal categorical representing underlying structures in a data set. Following Lépine & Strobl (2013), we use the Burt method, which performs a correspondence analysis of the Burt matrix (a matrix of the two-way cross-tabulations of all pairs of variables). We choose to keep only the first three dimensions, where each provides more than 11.11% of the information, according to the Kaiser criterion²¹, accounting for 60.16% of the total variance. The final index is standardized following a normal distribution between 0 and 1 (from less to more WE). The weights and contributions of the different variables included in the MCA are presented in Tables A1.1 and A1.2 in the Appendix.

2.2. Mothers' socio-economic status (SES)

Broadly speaking, the SES is also a complex multidimensional concept without consensus on its definition and measurement. According to the literature, wealth, education, and occupation are the main dimensions of the concept (Galobardes et al., 2007). Generally, most studies only use a single measure (income or education), whereas others analyze these three dimensions separately or combine them into a composite index (e.g., Bonnefond et al., 2015). For our research question and following previous authors, we prefer to use one multidimensional

²¹ The Kaiser criterion is used to determine the number of factors to retain during a factor analysis. One way to apply it is to only retain axes whose inertia is greater than the average inertia, here (100/9 components).

synthetic indicator of the mother's SES, and we did the same for the father's SES to include it as a control in our estimates. More precisely, we measure the mother's SES by integrating information on the household wealth, occupation and level of education of the mother (and vice versa for the father). As no household income or consumption information is available, we measure household wealth using the "wealth index" included in the DHS. An MCA procedure is again used, and we retain the first two dimensions, accounting for 83.75% of the total information. Then, we also standardized the women's SES indicator between 0 and 1 (from less to better socio-economic conditions). In the Appendix, Tables A1.3 and A1.4 give more details about the MCA's procedure, and Table A1.5 reports the descriptive statistics of the variables composing our women's SES indicator.

2.3. Child's nutrition variables

First, we are interested in examining the results of the height-for-age Z-scores (HAZ) of children aged 6-59 months, defined from an international sample (Brazil, Ghana, India, Norway, Oman and the USA) of ethnically, culturally and genetically diverse healthy children living under optimal conditions to reach their full genetic growth potential (World Health Organization, 2006). These Z-scores are expressed in units of standard deviation from the median of the reference population and capture the long-term effects of chronic malnutrition. We are also interested in examining the results in terms of dietary diversity (DD) scores for children aged 6-59 months, corresponding to the number of food groups consumed in the previous 24 hours. According to the latest guidelines, the eight food groups are breast milk, cereals, roots and tubers, legumes and nuts, dairy products, meat products, eggs, vitamin A-rich fruits and vegetables, and other fruits and vegetables (World Health Organization, 2017).

2.4. Control variables

Our econometric model includes a set of covariates about children, mothers, and household characteristics. The characteristics of children include age in months, birth order, number of births in the past three years, size at birth (small, average, tall), child's sex, place of delivery (hospital vs. at home), and breastfeeding status (still or not). The characteristics of mothers include their age (in years), body mass index (kg/m^2), and the number of children under five years old. The household's characteristics refer to the residence (urban vs. rural), religion, ecological region (mountain, hill, Terai), household size, father's SES and sex of the household head. In this regard, the sex of the head of the household is included as a control variable

because it simultaneously indicates mothers' socio-economic conditions (negatively correlated to the mother's SES: poorest women, working in agriculture and with low educational level) but also their level of empowerment (slightly positively correlated to our WE index; about 0.2 approximately). Table A1.6 in the Appendix presents more detailed descriptive statistics for all control variables used²².

3. Methods

3.1. Econometric framework

To investigate the relationship between children's nutrition (N), women's empowerment (WE), their socio-economic status (SES), and the interaction term between both variables ($WE*SES$), we estimate the following Equation:

$$N = \beta_0 + \beta_1 WE + \beta_2 SES + \beta_3 (WE*SES) + \beta_4 \mathbf{I} + \beta_5 \mathbf{M} + \beta_6 \mathbf{H} + \varepsilon \quad (1)$$

Where \mathbf{I} , \mathbf{M} , and \mathbf{H} are individual, mother, and household vectors of characteristics, respectively, and ε is the error term.

We hypothesize that WE and their SES will both improve HAZ and DD scores. We also assume that these two variables have potential interactive effects over and above their independent effects on child nutrition. We pay particular attention to the interaction term and its coefficient sign. A positive coefficient would indicate a positive relationship between WE and child nutrition, which is more important for children whose mother has a higher SES . Conversely, a negative coefficient would indicate a positive relationship between WE and child nutrition, which is more important for children whose mother has a lower SES . In this case, the positive correlation between WE and child nutrition would decrease as mothers' SES improved until reaching a turning point where the relationship would become negative. In other words, women's empowerment would mitigate the negative relationship between low maternal SES and child nutrition.

²² Estimations with DD as a dependent variable exclude controls about breastfeeding status (already included in the eight food groups of dietary diversity) and the mother's BMI (not determinant of children's DD).

3.2. Endogeneity issues

As a first step, we estimate the previous Equation (1) via the Ordinary Least Squares (OLS) approach. However, the main methodological issue of this reduced-form model lies in the potential endogeneity in estimated coefficients regarding the impact of SES, WE, and their interaction with children's nutrition. First, endogeneity issues may come from unobserved characteristics. It could be, for instance, the case for genetic factors determinants at the prenatal stage that we cannot control for (Almond, 2006). Second, the OLS estimator could be biased in the case of reverse causality. As such, Duflo (2012) provides evidence of a bidirectional relationship between WE and development: development, including women's access to education, earning opportunities and labor force participation, can play a significant role in reducing gender inequality, and continued discrimination against women can also hinder development. In our study, for instance, stunting children may affect the mothers' SES by delaying their school entry, which represents a cost for lunch in countries where meals are free or subsidized at school and postpones the mothers' return to the labor market (*e.g.*, Gelbach, 2002). As another example, child malnutrition can be interpreted as a failure to care for children that would increase the risk of domestic violence for women, justifying it as a just retaliation for their failure to be responsible (Chowdhury & Mathur, 2021). Therefore, we adopt an Instrumental Variable (IV) strategy to limit, as much as possible, these potential endogeneity issues.

In health economics, community aggregate variables are potentially good instruments and can be considered exogenous as they are outside the control of households and individuals (*i.e.*, Schultz, 1984). As such, we opt for the following instruments based on the 2016 NDHS: the PSU²³-level median of the indicators of SES and the PSU-level median of the type of combustible fuel (clean or not) as instruments of SES; the PSU-level median of respondents who have an account in a bank or other financial institution and the PSU-level median of the age at first cohabitation of respondents, as instruments of WE. Finally, we create another instrument for the interaction term by interacting: the median at the PSU-level of the type of cooking fuel with the median at the PSU-level of the indicator of mothers' SES. To have robust

²³ In the context of DHS, PSU stands for "Primary Sampling Unit." A PSU is a geographic area or cluster selected as the first stage in the sampling process for DHS. The purpose of dividing the survey area into PSUs is to facilitate the systematic and random selection of households and individuals for data collection. In our sample, we count a total of 383 PSUs.

estimators, clustered standard errors are used at the PSU-level All of these instruments are summarized in Table A1.7 in the Appendix.

One crucial challenge is finding suitable instruments correlated with the endogenous variable and uncorrelated with the unobservable. To develop further on instruments used for the mother's and father's SES, we support the proportion of households equipped with clean and modern fuel for cooking (*i.e.*, biogas, LPG, electricity, ethanol, or natural gas) compared to dirty traditional fuel (*i.e.*, charcoal, wood, or other organic combustibles) is a good indicator of material well-being of the household associated with health, prosperity and modernity (*i.e.*, Ali et al., 2019). The variable also includes a gender dimension, as women are generally responsible for the use of cooking fuels, with adverse health consequences when solid fuels are used instead of clean ones (Das et al., 2017; James et al., 2020). Regarding the instruments used for WE, the mean age at first cohabitation seems to be a good proxy for early marriage and childbearing (as women previously lived with their parents), which is associated with accepting higher levels of domestic violence or being left out of any role in the critical household decisions (*e.g.*, Field & Ambrus, 2008; Naved & Persson, 2005). Concerning women's access to a bank account, it may appear at first glance as an "economic" vision of WE not adapted for our study. However, we support here that women have more access to economic resources through a bank account when receiving funds from relatives, especially men who have migrated. From this perspective, a bank account can inform us about the presence or absence of men or other family members in the household, positively linked to WE (O'Hara & Clement, 2018). In the Appendix, Tables A1.8 and A1.9 report more exhaustively the standards tests for IV validity (weak identification, instruments exogeneity, and relevance). Overall, our instrumental strategy appears to satisfy exogeneity and relevance conditions while a bit weak in terms of identifying a causal effect, which is why we interpret results with caution in terms of correlation.

4. Results

We present OLS and IV estimates (control variables non-reported), considering as dependent variables HAZ in Tables 1.2 and 1.3 and DD in Tables 1.4 and 1.5. The full regression results are available in Table A1.10 in the Appendix.

4.1. Child anthropometry

Regarding OLS estimates, the first meaningful result is the positive correlation between WE and HAZ for the entire sample (at 5%), even if the coefficient is slightly smaller and less significant than the association with the mother's SES (at 1%). By sub-sample, we show a positive correlation between WE and the HAZ for girls (at 10%), children aged 6-23 months (at 5%), rural (at 5%), and hills' population (at 1%). Finally, the interaction term is positive for children aged 6-23 months (at 10%) and negative for those aged 24-59 months (at 5%). These results suggest that WE and women's SES are simultaneously positively correlated to children's HAZ before two years old and that WE mitigates the negative correlation between a low mother's SES and HAZ for 80% of children between 24-59 months. After controlling endogeneity issues, WE is positively and significantly linked to children's HAZ for the entire sample (at 1%), with a coefficient superior to OLS estimates, whereas the mother's SES is non-significant. Thanks to the interaction term (significant at 10%), the positive relationship between WE and HAZ seems to decrease with improvements in the mother's SES while always remaining positive. By sub-sample, we confirm the positive correlation between WE and girls' HAZ (at 5%) in the hills (at 5%) and in the Terai (at 10%). Note that the father's SES is also positively correlated to girls' HAZ (at 5%). More interestingly and contrary to previous estimates, WE is only correlated to the HAZ of urban areas (at 5%), while the father's SES is more important for rural areas (at 5%). Finally, WE is positively correlated to the HAZ of children aged 24-59 months (at 1%), where the interaction term is negative (at 1%). This result suggests a positive and decreasing relationship between WE and children's HAZ (24-59 months), with improvements in the mother's SES until a turning point at the 87th distribution. Hence, WE mitigates the negative relationship between a low mother's SES and children's HAZ for 95% of them.

4.2. Child dietary diversity

Regarding OLS estimates, we only underline the positive correlation between WE and children's DD aged 6-23 months (at 5%); women's SES and WE are also synergistically and positively correlated to DD (at 5%). Besides, this positive interactive effect is also observed for rural populations (at 10%). Controlling for endogeneity issues, we demonstrate that WE is positively correlated to the DD of the entire sample (at 1%), especially children aged 6-23

months (at 1%). Regarding the child's sex, we demonstrate a positive correlation (significant at 10%) for boys. We also show a positive relationship between WE and girls' DD, decreasing with improvements in the mother's SES until a turning point at the 83rd percentile of the distribution. Hence, WE mitigates the negative relationship between a low mother's SES and girls' DD for 95 % of them (at 10%). Concerning the place of residence, WE is positively associated with children's DD living in the Terai (at 1%) and has a positive but decreasing relationship with the mother's SES improvements in the hills (at 5%). The turning point of this positive effect is situated at the 38th percentile of the mother's SES distribution, which corresponds to a positive relationship for approximately 65% of these children whose mothers have the lowest SES. Finally, the mothers' SES is significant (at 10%) for urban areas, whereas there seems to exist a positive relationship between WE, mothers' SES and DD in rural areas (at 10%), although not jointly significant.

Table 1.2: OLS estimates by sub-samples for HAZ.

Dependent outcome:	Height-for-age																			
	Global		Boys		Girls		(6-23)		(24-59)		Urban		Rural		Mountain		Hill		Terai	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Mother's SES	0.487***	0.789*	0.532**	0.630	0.434*	1.142	0.913***	-0.301	0.247	1.389**	0.531**	1.239**	0.483	0.884	0.918*	-0.176	0.573**	0.855	0.347	0.385
	(0.174)	(0.466)	(0.231)	(0.578)	(0.241)	(0.699)	(0.284)	(0.705)	(0.214)	(0.550)	(0.217)	(0.579)	(0.321)	(0.781)	(0.513)	(1.246)	(0.278)	(0.838)	(0.260)	(0.672)
Father's SES	0.246	0.253	0.257	0.260	0.261	0.277	-0.114	-0.212	0.432*	0.455*	0.206	0.233	0.348	0.212	0.0432	-0.199	-0.296	-0.262	0.645**	0.655**
	(0.191)	(0.191)	(0.240)	(0.240)	(0.284)	(0.284)	(0.291)	(0.297)	(0.246)	(0.245)	(0.249)	(0.248)	(0.310)	(0.323)	(0.486)	(0.445)	(0.293)	(0.305)	(0.288)	(0.288)
WE	0.413**	0.588*	0.283	0.341	0.500*	0.905*	0.764**	-0.185	0.305	0.942**	0.179	0.583	0.575**	0.599	-0.658	-0.896	0.867***	0.929*	0.212	0.239
	(0.171)	(0.311)	(0.221)	(0.384)	(0.280)	(0.508)	(0.306)	(0.501)	(0.213)	(0.379)	(0.215)	(0.394)	(0.283)	(0.519)	(0.636)	(0.767)	(0.311)	(0.484)	(0.216)	(0.466)
(Mother's SES * WE)		-0.469		-0.152		-1.112		2.076*		-1.741**		-1.084		-0.247		1.889		-0.399		-0.128
		(0.671)		(0.799)		(1.060)		(1.094)		(0.789)		(0.791)		(1.275)		(1.758)		(1.211)		(0.930)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2161	2161	1085	1085	1076	1076	1425	1425	736	736	1196	1196	965	965	195	195	823	823	1143	1143
r2	0.269	0.270	0.223	0.224	0.319	0.319	0.231	0.196	0.140	0.140	0.241	0.241	0.325	0.295	0.413	0.378	0.291	0.277	0.233	0.221

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculation.

Table 1.3: IV estimates by sub-samples for HAZ.

Dependent outcome:	Height-for-age																			
	Global		Boys		Girls		(6-23)		(24-59)		Urban		Rural		Mountain		Hill		Terai	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Mother's SES	-0.0635	3.007*	0.418	3.135	-0.577	3.201	1.049	-0.465	-0.282	5.821**	-0.217	0.0852	-0.0487	4.195	-4.099	-0.146	-0.460	3.567	0.526	2.982
	(0.401)	(1.765)	(0.550)	(2.125)	(0.581)	(2.982)	(0.721)	(2.819)	(0.479)	(2.374)	(0.564)	(2.156)	(0.782)	(3.365)	(3.756)	(7.172)	(0.569)	(3.461)	(0.723)	(2.683)
Father's SES	0.952	1.040*	0.312	0.461	1.694**	1.672**	0.324	0.174	0.713	0.663	0.607	0.640	2.555**	1.659	6.791	7.288	0.927	1.289	0.314	0.0951
	(0.594)	(0.612)	(0.873)	(0.892)	(0.830)	(0.852)	(0.980)	(1.039)	(0.759)	(0.825)	(0.740)	(0.747)	(1.124)	(1.102)	(4.781)	(5.802)	(0.919)	(0.987)	(1.013)	(1.070)
WE	2.800***	5.040***	2.306	4.403*	3.211**	5.783**	1.678	0.531	3.770***	8.147***	3.647**	3.874*	1.542	4.827*	4.824	6.874	4.974**	6.349***	1.920*	4.183*
	(0.935)	(1.633)	(1.406)	(2.307)	(1.252)	(2.388)	(1.242)	(2.504)	(1.346)	(2.333)	(1.683)	(2.086)	(1.058)	(2.711)	(3.056)	(6.920)	(1.943)	(2.236)	(1.055)	(2.526)
(Mother's SES * WE)		-4.851*		-4.349		-5.852		2.554		-9.317***		-0.497		-5.827		-6.453		-5.883		-3.854
		(2.703)		(3.227)		(4.544)		(4.740)		(3.458)		(3.214)		(5.124)		(13.88)		(4.995)		(4.013)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2090	2090	1100	1100	990	990	707	707	1383	1383	1182	1182	908	908	178	178	832	832	1080	1080
r2	0.0521	-0.00357	0.0879	0.0337	0.0357	-0.0167	0.180	0.190	-0.0767	-0.267	-0.0285	-0.0321	0.0495	-0.00692	-0.711	-0.934	-0.0555	-0.0600	0.0759	0.0185
F-statistic	14.615	10.259	5.740	4.026	9.136	5.977	8.069	4.941	6.974	4.807	5.029	4.200	8.834	4.760	0.735	0.394	4.967	3.813	7.926	4.479

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculation.

Table 1.4: OLS estimates by sub-samples for DD.

Dependent outcome:	Dietary diversity																			
	Global		Boys		Girls		(6-23)		(24-59)		Urban		Rural		Mountain		Hill		Terai	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Mother's SES	0.547**	0.104	0.563*	0.000762	0.552	0.154	0.560**	-1.242**	0.690	1.074	0.501	0.479	0.895*	-2.023*	1.169*	0.751	0.177	0.474	0.830**	0.235
	(0.259)	(0.722)	(0.327)	(0.897)	(0.345)	(1.019)	(0.236)	(0.608)	(0.467)	(1.193)	(0.320)	(0.869)	(0.457)	(1.154)	(0.688)	(2.984)	(0.376)	(1.212)	(0.403)	(0.973)
Father's SES	0.842***	0.832***	0.735**	0.721**	1.000***	0.991***	0.754***	0.905***	0.903*	0.911*	0.624*	0.623*	1.230***	1.536***	0.706	1.080*	1.485***	1.580***	0.360	0.357
	(0.265)	(0.267)	(0.336)	(0.338)	(0.357)	(0.359)	(0.237)	(0.240)	(0.485)	(0.489)	(0.343)	(0.351)	(0.414)	(0.435)	(0.597)	(0.582)	(0.394)	(0.392)	(0.399)	(0.406)
WE	0.422	0.163	0.259	-0.0680	0.521	0.286	0.582**	0.0834	0.0805	0.300	0.318	0.305	0.516	-0.125	-0.926	-0.740	0.437	0.670	0.455	0.256
	(0.268)	(0.455)	(0.348)	(0.566)	(0.355)	(0.637)	(0.250)	(0.404)	(0.396)	(0.679)	(0.350)	(0.586)	(0.434)	(0.709)	(0.709)	(1.071)	(0.462)	(0.713)	(0.350)	(0.752)
(Mother's SES * WE)		0.710		0.895		0.645		2.189**		-0.631		0.0341		3.085*		0.0785		-0.541		0.817
		(1.093)		(1.359)		(1.537)		(0.908)		(1.790)		(1.332)		(1.762)		(4.228)		(1.720)		(1.622)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2161	2161	1085	1085	1076	1076	1425	1425	736	736	1196	1196	965	965	195	195	823	823	1143	1143
r2	0.269	0.270	0.223	0.224	0.319	0.319	0.231	0.196	0.140	0.140	0.241	0.241	0.325	0.295	0.413	0.378	0.291	0.277	0.233	0.221

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculation.

Table 1.5: IV estimates by sub-samples for DD.

Dependent outcome:	Dietary diversity																			
	Global		Boys		Girls		(6-23)		(24-59)		Urban		Rural		Mountain		Hill		Terai	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Mother's SES	0.569	3.314	0.500	-0.951	0.818	7.895**	-0.187	0.346	1.793*	7.548	1.339*	-0.628	1.128	8.481*	2.250**	4.710	-0.104	9.794**	1.372	-2.485
	(0.541)	(2.571)	(0.682)	(3.401)	(0.869)	(3.852)	(0.612)	(2.748)	(0.930)	(5.014)	(0.719)	(3.353)	(0.939)	(5.001)	(1.137)	(2.191)	(0.808)	(4.178)	(1.013)	(3.998)
Father's SES	-0.160	0.0498	-0.393	-0.598	0.0818	0.0762	0.0896	0.138	-0.398	-0.252	-1.378	-1.689	2.236	1.827	-0.557	-0.537	1.185	1.553	-2.223	-2.614*
	(0.784)	(0.832)	(1.029)	(1.102)	(1.236)	(1.362)	(0.880)	(0.938)	(1.379)	(1.426)	(0.933)	(1.039)	(1.443)	(1.472)	(2.310)	(2.752)	(1.020)	(1.138)	(1.364)	(1.412)
WE	3.171***	5.383**	2.729*	1.642	3.261	9.522**	4.465***	4.879*	-0.750	3.812	1.574	0.126	1.955	8.913*	-0.456	1.056	0.649	5.576*	5.393***	1.544
	(1.212)	(2.430)	(1.435)	(3.119)	(2.190)	(3.938)	(1.237)	(2.656)	(2.604)	(4.104)	(1.493)	(2.736)	(1.759)	(4.928)	(1.876)	(9.603)	(1.960)	(3.167)	(1.427)	(3.937)
(Mother's SES * WE)		-4.620		2.487		-11.53*		-0.886		-9.741		3.319		-12.33		-4.476		-14.62**		7.037
		(4.293)		(5.749)		(6.298)		(4.623)		(8.432)		(5.446)		(8.485)		(33.96)		(6.384)		(7.044)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2161	2161	1085	1085	1076	1076	1425	1425	736	736	1196	1196	965	965	195	195	823	823	1143	1143
r2	0.211	0.177	0.167	0.170	0.269	0.108	0.0754	0.0672	0.120	0.0881	0.201	0.194	0.294	0.122	0.398	0.395	0.288	0.203	-0.00901	0.0237
F-statistic	14.663	8.878	9.812	4.995	4.601	3.368	11.726	6.173	3.107	2.739	10.121	6.622	5.390	2.576	3.044	0.234	6.212	4.297	9.721	5.387

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculation.

5. Discussion

At first sight, standard OLS estimates show that maternal SES, in contrast to WE, is a crucial determinant of children's DD and is more positively correlated with children's HAZ than WE. These results justify the long-standing poverty reduction strategies, which mainly focus on promoting empowerment through its economic version, namely women's SES. Nevertheless, by measuring WE through non-economic dimensions based on different forms of *power* and aiming to control for endogeneity issues, our analysis allows us to understand better why promoting empowerment in its original and so-called "radical" concept may be a promising strategy to address these malnutrition challenges further. Indeed, using an IV strategy, our results show that WE is positively correlated with children's HAZ (especially between 24-59 months) and children's DD (especially between 6-23 months), in contrast to maternal SES, which is not significant in IV estimates. We also highlight that WE can moderate the negative association between low maternal SES and children's HAZ. As a result, given the bidirectional relationship between WE and women's SES and considering endogeneity issues, WE may be more important locally than addressing women's SES to promote children's dietary diversity and fight against chronic malnutrition.

Additionally, we have found that the relationship between WE and child malnutrition varies depending on children's sex and age. Regarding dietary diversity, we observe a positive correlation between WE and boys' DD and a positive relationship that mitigates a low mother's SES for girls' DD. These results are interesting when compared with those of the study by Saville et al. (2022), suggesting that women tend to compensate for boys' disadvantage (which exists at birth) by increasing their dietary diversity (between 6 and 23 months). According to our results, mothers are, indeed, aware of this male growth delay at a young age and compensate for it. Besides, our results show that women compensate through their WE for girls' low DD when their socio-economic conditions are somewhat unfavorable. Indeed, the preference for boys is known in the Asian region and will apply in particular in cases of low socio-economic status of the household (scarcity of food resources). In terms of chronic malnutrition, we discovered a positive link between WE and girls' HAZ, while the results were not significant for boys. According to Saville et al. (2022), boys rapidly quickly catch up with girls in terms of growth when introducing complementary foods. Hence, our results here suggest that women may aim to counterbalance any gender bias in the region when they have more WE. Therefore, WE seems to be a strategy for addressing gender inequalities in child malnutrition. Future

research should delve deeper into this potential gender bias, exploring how women's behavior in child nutrition changes as they gain more autonomy.

Regarding our analysis by ecological zone, we cannot conclude about any WE benefits in the mountains, likely due to our small sample size. Nevertheless, we demonstrate that WE is positively correlated to children's HAZ in the Hills and attenuates the negative relationship between a low mother's SES and DD there. In addition, we show that WE is positively correlated to children's HAZ and DD improvements in the Terai. This region is known for its geographical and cultural proximity to India, where intense pressure is exerted on women (restrictions on mobility, decision-making etc.).

Finally, the literature shows that women in rural areas have lower levels of education than those in urban areas, with multiple negative consequences for health seeking, care practices and child feeding (Smith & al., 2005). The literature also shows that women's participation in agricultural production through hours worked can increase children's DD in rural areas (Malapit et al., 2013). Following the literature conclusions, we examined the rural-urban disparities in child malnutrition that have been identified in many developing countries (*i.e.*, Smith et al., 2005). First, regarding children's HAZ, we only show a positive relationship with the father's SES. More interestingly, mothers' SES is negatively correlated with children's HAZ, although not significantly. Concerning children's DD, both WE and women's SES seem to be essential for improving children's DD in rural areas, although we cannot show significant interactive effects with our specification model. These somewhat mixed results seem to reflect a complex reality, particularly in rural areas, which arouses interest in public policies. In this regard, we first encourage investing in education to achieve better nutritional outcomes, with a particular focus on girls, as their education level is more important than their future husbands to act for their child's health (Nepal, 2018). Then, we underline the role of women's SES in increasing children's DD but caution about the potential negative consequences of agricultural activities on children's HAZ. Indeed, agriculture is undergoing a transition with the "feminization" of labor (Grassi & al., 2015), where women have to compensate for the absence of husbands working abroad (Tamang & al., 2014). These labor-intensive activities do not exclude other women's activities, such as domestic work and childcare, which are detrimental to women's and children's well-being (Pattnaik & al., 2018). Therefore, we call for policies supporting women in their new roles, taking into account their need to adapt to new economic constraints that may negatively affect their children's health (Brauner-Otto et al., 2019).

6. Conclusion

While the role of WE in child nutrition is now well known, WE is often reduced to its economic dimension indirectly measured by women's education and employment. However, feminist pioneers of the concept criticize how WE is instrumented to promote women's SES, forgetting the initial idea to increase their power to better results. From this perspective, this article aims to analyze the relationship between WE, in a "radical" conception, and children's nutrition, testing for interaction effects with the mothers' SES. Based on the 2016 NDHS, we construct representative indices of these multidimensional phenomena using an MCA approach and assess their impact on children's HAZ and DD. Intending to address endogeneity issues through an IV strategy, we furthermore highlight the interactive effects of these two conceptions of empowerment, providing interesting conclusions in many respects.

First, we show that WE can positively affect the DD of children before 24 months and promote their HAZ in the long run, also contributing to mitigating the negative effect of a low mother's SES on child nutritional outcomes. Second, we show that WE can reduce gender inequalities in Nepal, contributing to increasing girls' nutrition, which has important implications, as two-thirds of malnutrition issues are due to intergenerational transmission (Thompson, 2014). Thus, improving the nutritional situation of young girls can improve the nutritional status of future mothers who will give birth to healthier children and break the vicious circle of malnutrition locally, deeply rooted in the gender issue. Finally, regarding the interest of policies in promoting women's SES, especially in rural areas, we recommend policies that promote women's education and stress the need to support working women. Our results make it possible to qualify the literature where the participation of women in the labor market is seen as a factor of empowerment. We underscore to pay attention to women agricultural workers (Komatsu et al., 2018) and, more broadly, to the increase in female labor force participation in agriculture since the mid-1900s. In this perspective, future works must explore the challenge of increasing women's SES in low-middle-income countries like Nepal and its multiple consequences on individual health. To conclude, although our work does not address which are the most important dimensions of WE to fight child malnutrition, we highlight the value of implementing new policies focusing on WE in terms of power to solve this "Asian Enigma."

Appendix

Text box A1.1: Additional information on the sample of data analyzed.

Regarding children's height-for-age (HAZ), we use the standard deviations based on new WHO measurements (calculated using the new Child Growth Standards released by the World Health Organization on April 27, 2006). In the database, measures were presented with two implied decimal places (no decimal points are included in the data file), which is why, to produce the actual measure, we divided the variable by 100. Overall, data on HAZ were available for 2379 children (0-60 months): 7 were coded as missing values, 177 were deleted because children were no longer alive, and 444 were deleted to exclude the less than six months. We finally have information about 2151 (6-59 months) children, whose HAZ ranges from -5.85 and 5.54 standard deviations to the mean.

Concerning children's dietary diversity (DD), we use the recommendations of the WHO about Infant and Young child feeding, constructing the traditional seven food groups including grains, roots and tubers; legumes and nuts; dairy products (milk, yogurt, cheese); flesh foods (meat, fish, poultry, liver or other organs); eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables. We also take into account the revision by the World Health Organization (2017), which concerns the addition of "breast milk" as an eighth food group. Therefore, of the 5038 children, 2953 were still breastfed, and 2738 had information on the seven food groups mentioned above. We then excluded the 177 children who were no longer alive and the 444 who were less than six months old. Finally, we have information on 2225 children (6-59 months) whose DD ranged from 0 to 8 food groups, with a mean of 3.64 food groups and a standard deviation from the mean of 1.87.

References

World Health Organization. (2017). Global Nutrition Monitoring Framework: operational guidance for tracking progress in meeting targets for 2025.

Table A1.1: MCA's statistics for row and column categories in symmetric normalization (measure of WE).

	Overall			Dimension 1			Dimension 2			Dimension 3		
	mass	quality	%inert	coord	sqcorr	contrib	coord	sqcorr	contrib	coord	sqcorr	contrib
Beating if: goes out without permission												
<i>No</i>	0.052	0.365	0.003	0.014	0.043	0.000	0.035	0.254	0.004	0.018	0.068	0.002
<i>Yes</i>	0.007	0.365	0.021	-0.107	0.043	0.003	-0.260	0.254	0.027	-0.134	0.068	0.012
Beating if: neglects the children												
<i>No</i>	0.045	0.257	0.005	0.015	0.022	0.000	0.042	0.171	0.005	0.026	0.064	0.003
<i>Yes</i>	0.013	0.257	0.018	-0.050	0.022	0.001	-0.142	0.171	0.015	-0.087	0.064	0.010
Beating if: argues with him												
<i>No</i>	0.054	0.335	0.002	0.019	0.098	0.001	0.026	0.180	0.002	0.015	0.057	0.001
<i>Yes</i>	0.005	0.335	0.024	-0.203	0.098	0.008	-0.276	0.180	0.022	-0.155	0.057	0.012
Beating if: refuses sex												
<i>No</i>	0.057	0.322	0.001	0.009	0.075	0.000	0.014	0.201	0.001	0.007	0.046	0.000
<i>Yes</i>	0.002	0.322	0.021	-0.282	0.075	0.005	-0.461	0.201	0.021	-0.221	0.046	0.008
Beating if: burns the food												
<i>No</i>	0.057	0.324	0.001	0.010	0.103	0.000	0.013	0.175	0.001	0.007	0.046	0.000
<i>Yes</i>	0.002	0.324	0.019	-0.296	0.103	0.007	-0.385	0.175	0.016	-0.197	0.046	0.008
Health care: permission												
<i>Big problem</i>	0.017	0.707	0.018	-0.177	0.338	0.022	-0.180	0.348	0.032	-0.045	0.021	0.003
<i>Not a big problem</i>	0.041	0.707	0.008	0.074	0.338	0.009	0.075	0.348	0.013	0.019	0.021	0.001
Health care: money												
<i>Big problem</i>	0.035	0.602	0.013	-0.078	0.180	0.009	-0.115	0.397	0.026	-0.029	0.025	0.003
<i>Not a big problem</i>	0.023	0.602	0.020	0.117	0.180	0.013	0.174	0.397	0.040	0.044	0.025	0.004
Health care: distance												
<i>Big problem</i>	0.036	0.589	0.015	-0.073	0.143	0.008	-0.124	0.416	0.031	-0.033	0.031	0.004
<i>Not a big problem</i>	0.022	0.589	0.025	0.117	0.143	0.012	0.200	0.416	0.051	0.054	0.031	0.006
Health care: go alone												
<i>Big problem</i>	0.043	0.548	0.011	-0.060	0.155	0.006	-0.091	0.360	0.020	-0.028	0.033	0.003
<i>Not a big problem</i>	0.016	0.548	0.030	0.159	0.155	0.016	0.242	0.360	0.053	0.073	0.033	0.008
Health care: health provider												
<i>Big problem</i>	0.042	0.547	0.008	-0.052	0.161	0.005	-0.077	0.351	0.014	-0.024	0.034	0.002
<i>Not a big problem</i>	0.017	0.547	0.019	0.126	0.161	0.011	0.186	0.351	0.034	0.058	0.034	0.006
Health mothers' groups												
<i>No</i>	0.034	0.170	0.002	-0.032	0.162	0.001	-0.007	0.008	0.000	0.000	0.000	0.000
<i>Yes</i>	0.025	0.170	0.003	0.044	0.162	0.002	0.010	0.008	0.000	-0.000	0.000	0.000
Growth monitoring promotion groups												
<i>No</i>	0.042	0.187	0.002	-0.027	0.186	0.001	0.001	0.000	0.000	-0.001	0.000	0.000
<i>Yes</i>	0.016	0.187	0.005	0.069	0.186	0.003	-0.003	0.000	0.000	0.002	0.000	0.000
Decision: Respondent's healthcare												
<i>Respondent alone</i>	0.013	0.831	0.031	0.247	0.279	0.031	0.166	0.126	0.020	-0.305	0.426	0.116
<i>Respondent and husband</i>	0.017	0.600	0.025	0.185	0.255	0.023	-0.012	0.001	0.000	0.215	0.344	0.076
<i>Husband</i>	0.018	0.549	0.024	-0.010	0.001	0.000	-0.253	0.546	0.066	0.015	0.002	0.000
<i>Someone else</i>	0.011	0.833	0.052	-0.534	0.690	0.127	0.243	0.143	0.037	0.005	0.000	0.000
<i>Other</i>	0.000	0.019	0.025	-0.416	0.016	0.001	0.033	0.000	0.000	-0.173	0.003	0.001
Decision: Large household purchases												
<i>Respondent alone</i>	0.016	0.805	0.030	0.282	0.483	0.052	0.064	0.025	0.004	-0.221	0.297	0.078
<i>Respondent and husband</i>	0.009	0.756	0.022	0.267	0.316	0.025	-0.020	0.002	0.000	0.314	0.438	0.084
<i>Husband</i>	0.013	0.658	0.028	0.031	0.005	0.000	-0.346	0.643	0.088	0.043	0.010	0.002
<i>Someone else</i>	0.020	0.814	0.044	-0.352	0.651	0.101	0.175	0.161	0.035	0.018	0.002	0.001
<i>Other</i>	0.000	0.015	0.030	-0.216	0.008	0.001	0.163	0.005	0.001	-0.122	0.003	0.001
Decision: Visit family or relatives												
<i>Respondent alone</i>	0.012	0.813	0.031	0.282	0.347	0.038	0.107	0.050	0.008	-0.309	0.417	0.114
<i>Respondent and husband</i>	0.013	0.647	0.030	0.239	0.291	0.030	-0.031	0.005	0.001	0.263	0.351	0.090
<i>Husband</i>	0.015	0.565	0.028	0.040	0.009	0.001	-0.303	0.555	0.077	0.005	0.000	0.000
<i>Someone else</i>	0.018	0.810	0.049	-0.392	0.644	0.111	0.198	0.165	0.040	0.011	0.001	0.000
<i>Other</i>	0.000	0.009	0.031	-0.212	0.007	0.001	0.100	0.001	0.000	-0.092	0.001	0.000
Decision: Using husband earns												
<i>Respondent alone</i>	0.008	0.855	0.027	0.309	0.304	0.029	0.155	0.076	0.010	-0.386	0.474	0.111
<i>Respondent and husband</i>	0.022	0.667	0.020	0.178	0.405	0.028	-0.009	0.001	0.000	0.143	0.260	0.045
<i>Husband</i>	0.018	0.547	0.018	-0.049	0.027	0.002	-0.215	0.517	0.046	-0.017	0.003	0.000
<i>Someone else</i>	0.010	0.854	0.045	-0.508	0.680	0.107	0.256	0.174	0.038	0.003	0.000	0.000
<i>Other</i>	0.001	0.562	0.001	-0.189	0.384	0.001	0.127	0.175	0.001	-0.018	0.003	0.000
Decision: Children's education												
<i>Respondent alone</i>	0.010	0.829	0.028	0.229	0.209	0.021	0.150	0.090	0.013	-0.365	0.530	0.130
<i>Respondent and husband</i>	0.024	0.682	0.018	0.145	0.331	0.020	-0.013	0.003	0.000	0.149	0.348	0.053
<i>Husband</i>	0.013	0.501	0.024	-0.061	0.024	0.002	-0.273	0.477	0.056	-0.004	0.000	0.000
<i>Someone else</i>	0.008	0.873	0.039	-0.559	0.706	0.097	0.271	0.166	0.032	0.014	0.000	0.000
<i>Other</i>	0.004	0.456	0.004	-0.190	0.358	0.005	0.098	0.097	0.002	-0.010	0.001	0.000

Source: Author's calculations.

Table A1.2: Results from the MCA (measure of WE).

Dimensions	Principal Inertia	Percent	Cumul percent
dim 1	.025025	28.42	28.42
dim 2	.0177742	20.18	48.60
dim 3	.010184	11.56	60.16
dim 4	.0073836	8.38	68.54
dim 5	.0071277	8.09	76.64
dim 6	.0044804	5.09	81.73
dim 7	.0004806	0.55	82.27
dim 8	4.26e-06	0.00	82.28
dim 9	3.02e-08	0.00	82.28
Total	.0880694	100.00	

Source: Author's calculations.

Table A1.3: MCA's statistics for row and column categories in symmetric normalization (measure of the mother's SES).

	mass	Overall	%inert	coord	Dimension 1		Dimension 2		
		quality			sqcorr	contrib	coord	sqcorr	contrib
Wealth									
<i>Poorest</i>	0.088	0.809	0.156	0.389	0.802	0.155	0.035	0.006	0.029
<i>Poorer</i>	0.074	0.629	0.031	0.165	0.603	0.024	0.034	0.026	0.024
<i>Middle</i>	0.067	0.465	0.009	-0.075	0.399	0.004	-0.030	0.066	0.017
<i>Richer</i>	0.060	0.780	0.059	-0.271	0.701	0.052	-0.090	0.078	0.136
<i>Richest</i>	0.044	0.871	0.155	-0.572	0.866	0.167	0.044	0.005	0.023
Mother's level of education									
<i>No education</i>	0.113	0.861	0.049	0.197	0.838	0.051	-0.033	0.023	0.033
<i>Premiary</i>	0.067	0.711	0.019	0.146	0.694	0.017	0.022	0.016	0.009
<i>Secondary</i>	0.108	0.170	0.016	-0.047	0.136	0.003	-0.024	0.035	0.017
<i>Higher</i>	0.046	0.959	0.161	-0.591	0.930	0.186	0.105	0.029	0.138
Mother's occupation									
<i>Did not work</i>	0.121	0.669	0.088	-0.207	0.552	0.061	-0.095	0.117	0.304
<i>Professional/managerial</i>	0.046	0.962	0.111	-0.479	0.895	0.124	0.131	0.067	0.218
<i>Agricultural</i>	0.166	0.881	0.145	0.284	0.869	0.157	0.033	0.012	0.051

Source: Author's calculations.

Table A1.4: Results from the MCA (measure of the mother's SES).

Dimensions	Principal inertia	Percent	Cumul percent
dim 1	.0855205	80.34	80.34
dim 2	.0036255	3.41	83.75
dim 3	.0026922	2.53	86.28
dim 4	.0002605	0.24	86.52
dim 5	7.12e-06	0.01	86.53
Total	.1064459	100.00	

Source: Author's calculations.

Table A1.5: Descriptive statistics of constitutive elements of the measure of the mothers' SES.

Categorcial variables	Freq.	Percent
Wealth index		
<i>First quintile</i>	1,164	26.50
<i>Second quintile</i>	970	22.08
<i>Third quintile</i>	892	20.31
<i>Fourth quintile</i>	794	18.07
<i>Fifth quintile</i>	573	13.04
Total	4,348	100.00
Mother's occupation		
<i>Not work</i>	1,606	36.56
<i>Agricultural/self-employed</i>	604	13.75
<i>Others categories</i>	2,183	49.69
Total	4,393	100.00
Mother's level of education		
<i>No Education</i>	1,495	34.03
<i>Primary</i>	880	20.03
<i>Secondary</i>	1,423	32.39
<i>Higher</i>	595	13.54
Total	4,393	100.00

Source: Author's calculations.

Table A1.6: Descriptive statistics of control variables.

	Variables	Obs.	Type of variable	Mean	Std. Dev.	Min.	Max.
<i>Child's characteristics</i>	Child's age (months)	4,393	Continuous	32.82677	15.68463	6	60
	Birth order	4,393	Continuous	2.273162	1.532154	1	14
	Birth interval (3 years)	4,393	Continuous	.8019577	.5835681	0	3
	Size at birth	4,383	Qualitative	2.856947	.889272	1	4
	Child's sex	4,393	Dummy	1.470749	.4992005	1	2
	Breastfeeding status	4,393	Dummy	.5688595	.495292	0	1
<i>Mother's characteristics</i>	Place of delivery	4,393	Dummy	.58229	.493238	0	1
	Mother's age	4,393	Continuous	26.50922	5.43943	15	49
	Mother's BMI	2,214	Continuous	21.49534	3.464771	14.23	38.05
	Number of children less than five years old	4,393	Continuous	1.048941	.8592258	0	6
<i>Household's characteristics</i>	Religion	4,393	Qualitative	1.273162	.783802	1	5
	Household's size	4,393	Continuous	6.181653	2.945662	2	38
	Sex of the household head	4,393	Dummy	1.310266	.4626552	1	2
	Father's SES	4,300	Continuous	0.30726	.2264715	0.01	1
	Type of residence	4,393	Dummy	1.427954	.4948384	1	2
	Ecological region	4,393	Qualitative	2.410653	.6467625	1	3

Source: Author's calculations.

Table A1.7: Full set of instruments used by endogenous variables.

Endogenous variables	Instruments
Mother's SES/ Father's SES	The PSU-level median of the indicator of SES considered; the PSU-level median of the type of combustible fuel.
Empowerment (WE)	The PSU-level median of respondents who have an account in a bank or other financial institution; the PSU-level median of respondents' age at first cohabitation.
Interaction term (Mother's SES * WE)	(The PSU-level median of the mother's SES indicator * the PSU-level median of the type of combustible fuel).

Source: Author's calculations.

Table A1.8: Tests of instrument validity.

Dependent variable	Height-for-age		Dietary diversity	
	Linear	Interacted	Linear	Interacted
Tests of over-identification (instrument exogeneity)				
<i>H0: Over-identifying restrictions are valid</i>				
Hansen J-statistic	0.316	0.113	1.388	0.918
Chi2 distribution p-value	0.8539	0.9449	0.4995	0.6320
Tests of under-identification (instrument relevance)				
<i>H0: Equations are under-identified</i>				
Kleibergen Papp rk LM statistic	71.463	33.434	71.678	23.999
Chi2 distribution p-value	0.0000	0.0000	0.0000	0.0000
Tests of weak identification				
<i>Weak if: Wald F-stat < Stock-Yogo test</i>				
Cragg-Donal Wald F-statistic	14.615	10.259	14.663	8.878
Stock-Yogo weak ID test critical values (10%)	9.53	Not available	9.53	Not available

Source: Author's calculations.

Table A1.9: First-stage regression results.

HAZ	Linear			Interacted			
	Father's SES	Mother's SES	WE	Father's SES	Mother's SES	WE	INTER
Father's SES (PSU-level median)	0.647*** (0.0476)	0.0249 (0.0464)	0.145*** (0.0420)	0.649*** (0.0512)	0.0234 (0.0499)	0.134*** (0.0451)	0.0334 (0.0405)
Mother's SES (PSU-level median)	0.0618 (0.0378)	0.705*** (0.0368)	-0.0451 (0.0333)	0.0620 (0.0380)	0.704*** (0.0370)	-0.0473 (0.0335)	0.410*** (0.0300)
Combustible fuel (PSU-level median)	0.0578*** (0.0138)	0.0700*** (0.0135)	0.0326*** (0.0122)	0.0597* (0.0322)	0.0677** (0.0314)	0.0156 (0.0284)	-0.0199 (0.0255)
Bank account (PSU-level median)	-0.00335 (0.0103)	0.00601 (0.0101)	0.0430*** (0.00911)	-0.00337 (0.0104)	0.00604 (0.0101)	0.0432*** (0.00912)	0.0218*** (0.00818)
Cohabitation age (PSU-level median)	-0.0120*** (0.00303)	-0.0103*** (0.00295)	0.0130*** (0.00267)	-0.0120*** (0.00305)	-0.0103*** (0.00298)	0.0128*** (0.00269)	-0.00165 (0.00241)
Mother's SES * Combustible fuel (PSU-level median)				-0.00457 (0.0714)	0.00567 (0.0697)	0.0418 (0.0629)	0.214*** (0.0565)
Observations	2090	2090	2090	2090	2090	2090	2090
F-stat	154.60	282.71	28.40	128.77	235.48	23.73	192.54

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculations.

DD	Linear			Interacted			
	Father's SES	Mother's SES	WE	Father's SES	Mother's SES	WE	INTER
Father's SES (PSU-level median)	0.719*** (0.0492)	0.126*** (0.0449)	0.156*** (0.0435)	0.718*** (0.0529)	0.151*** (0.0482)	0.152*** (0.0468)	0.151*** (0.0385)
Mother's SES (PSU-level median)	0.0485 (0.0395)	0.673*** (0.0360)	-0.0306 (0.0349)	0.0483 (0.0396)	0.677*** (0.0361)	-0.0313 (0.0350)	0.375*** (0.0288)
Combustible fuel (PSU-level median)	0.0165 (0.0143)	0.0450*** (0.0131)	0.0241* (0.0127)	0.0148 (0.0342)	0.0852*** (0.0312)	0.0166 (0.0302)	0.000600 (0.0249)
Bank account (PSU-level median)	-0.000636 (0.0110)	-0.000201 (0.0100)	0.0538*** (0.00971)	-0.000625 (0.0110)	-0.000459 (0.0100)	0.0538*** (0.00972)	0.0243*** (0.00800)
Cohabitation age (PSU-level median)	-0.00890*** (0.00303)	-0.00821*** (0.00276)	0.0126*** (0.00268)	-0.00892*** (0.00305)	-0.00775*** (0.00278)	0.0126*** (0.00270)	0.0000945 (0.00222)
Mother's SES * Combustible fuel (PSU-level median)				0.00412 (0.0758)	-0.0981 (0.0691)	0.0185 (0.0670)	0.113** (0.0552)
Observations	2161	2161	2161	2161	2161	2161	2161
F-stat	143.11	298.12	29.88	119.20	248.89	24.90	206.40

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculations.

Table A1.10: OLS and IV estimates, all control variables included (measure of the mother's SES).

	Height-for-age				Dietary diversity			
	OLS	OLS	IV	IV	OLS	OLS	IV	IV
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Father's SES	0.246 (0.191)	0.253 (0.191)	0.952 (0.594)	1.040* (0.612)	0.842*** (0.265)	0.832*** (0.267)	-0.160 (0.784)	0.0498 (0.832)
Mother's SES	0.487*** (0.174)	0.789* (0.466)	-0.0635 (0.401)	3.007* (1.765)	0.547** (0.259)	0.104 (0.722)	0.569 (0.541)	3.314 (2.571)
Women's empowerment	0.413** (0.171)	0.588* (0.311)	2.800*** (0.935)	5.040*** (1.633)	0.422 (0.268)	0.163 (0.455)	3.171*** (1.212)	5.383** (2.430)
Child's age	-0.0271*** (0.00293)	-0.0272*** (0.00293)	-0.0268*** (0.00305)	-0.0271*** (0.00314)	-0.0366*** (0.00228)	-0.0365*** (0.00228)	-0.0371*** (0.00266)	-0.0373*** (0.00272)
Child's sex (girl)	0.0446 (0.0664)	0.0436 (0.0665)	0.0398 (0.0702)	0.0263 (0.0727)	-0.142* (0.0782)	-0.141* (0.0781)	-0.121 (0.0934)	-0.123 (0.0954)
Birth order	-0.0790*** (0.0304)	-0.0801*** (0.0305)	-0.0418 (0.0303)	-0.0483 (0.0314)	0.0750* (0.0396)	0.0764* (0.0392)	0.0675 (0.0422)	0.0664 (0.0431)
Births last 3 years	-0.310*** (0.0564)	-0.308*** (0.0564)	-0.241*** (0.0640)	-0.212*** (0.0682)	-1.258*** (0.135)	-1.260*** (0.135)	-1.275*** (0.0956)	-1.261*** (0.0986)
Size at birth (average)	-0.167** (0.0691)	-0.169** (0.0691)	-0.200** (0.0777)	-0.219*** (0.0808)	-0.204* (0.104)	-0.202* (0.104)	-0.238** (0.104)	-0.258** (0.108)
Size at birth (smaller than average)	-0.391*** (0.0863)	-0.389*** (0.0862)	-0.360*** (0.0954)	-0.339*** (0.0989)	-0.166 (0.137)	-0.165 (0.138)	-0.132 (0.128)	-0.122 (0.131)
Place of delivery (Hospital)	0.0930 (0.0611)	0.0920 (0.0612)	0.00305 (0.964)	-0.0198 (0.779)	0.123 (0.0856)	0.123 (0.0856)	0.105 (0.0890)	0.0788 (0.0944)
Breastfeeding status (Yes)	-0.307*** (0.0735)	-0.308*** (0.0735)	-0.330*** (0.0820)	-0.345*** (0.0848)				
Mother's BMI	0.0298*** (0.00860)	0.0303*** (0.00862)	0.0150 (0.00963)	0.0175* (0.00997)				
Mother's age	0.00795 (0.00731)	0.00837 (0.00730)	-0.00862 (0.00878)	-0.00698 (0.00905)	-0.00922 (0.0113)	-0.00991 (0.0112)	-0.0225* (0.0123)	-0.0224* (0.0126)
Number of children less than 5 years old	-0.0471 (0.0455)	-0.0477 (0.0456)	-0.0771 (0.0494)	-0.0904* (0.0515)	-0.112* (0.0653)	-0.111* (0.0652)	-0.131** (0.0611)	-0.138** (0.0628)
Size of the household	-0.00220 (0.0104)	-0.00239 (0.0104)	0.0252 (0.0171)	0.0288 (0.0178)	0.0171 (0.0162)	0.0177 (0.0162)	0.0558*** (0.0213)	0.0568*** (0.0218)
Place of residence (rural)	-0.0709 (0.0686)	-0.0759 (0.0697)	0.00809 (0.0655)	-0.0292 (0.0699)	-0.101 (0.0899)	-0.0932 (0.0908)	0.00757 (0.0903)	-0.0188 (0.0949)
Region of development (Hill)	0.264** (0.110)	0.261** (0.110)	0.260** (0.108)	0.227** (0.112)	0.106 (0.147)	0.107 (0.148)	0.108 (0.144)	0.125 (0.149)
Region of development (Terai)	0.366*** (0.109)	0.358*** (0.110)	0.455*** (0.116)	0.387*** (0.125)	-0.485*** (0.145)	-0.477*** (0.144)	-0.345** (0.174)	-0.354** (0.178)
Religion (Buddhist)	0.259* (0.143)	0.256* (0.143)	0.288** (0.139)	0.254* (0.144)	-0.445** (0.222)	-0.444** (0.221)	-0.530*** (0.193)	-0.531*** (0.197)
Religion (Muslim)	0.0696 (0.153)	0.0657 (0.154)	0.174 (0.130)	0.153 (0.134)	-0.0989 (0.146)	-0.0965 (0.147)	-0.00423 (0.147)	0.00193 (0.150)
Religion (Kirat)	-0.112 (0.236)	-0.118 (0.235)	-0.111 (0.264)	-0.179 (0.274)	-0.430 (0.394)	-0.427 (0.394)	-0.401 (0.379)	-0.393 (0.388)
Religion (Christian)	-0.243 (0.302)	-0.237 (0.302)	-0.311 (0.240)	-0.265 (0.248)	0.0356 (0.246)	0.0288 (0.248)	-0.0908 (0.280)	-0.0664 (0.287)
Household head (female)	-0.129** (0.0639)	-0.132** (0.0643)	-0.247*** (0.0758)	-0.306*** (0.0859)	0.278*** (0.104)	0.283*** (0.104)	0.159 (0.100)	0.106 (0.114)
Interaction term		-0.469 (0.671)		-4.851* (2.703)		0.710 (1.093)		-4.620 (4.293)
Constant	-1.571*** (0.359)	-1.687*** (0.392)	-2.523*** (0.475)	-3.884*** (0.925)	5.748*** (0.370)	5.904*** (0.433)	4.533*** (0.635)	3.245** (1.380)
Observations	2090	2090	2090	2090	2161	2161	2161	2161
R-squared	0.147	0.147			0.269	0.270		
F-statistic			14.28	13.03			32.90	30.13

Robust standard errors in parentheses: *p<0.05, **p<0.01, ***p<0.001.

Source: Author's calculations.

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Chapter 2: "Mother's milk": Is there a social reversal in breastfeeding practices along with economic development?

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Abstract:

The purpose of this article is to test the existence of a reversal in the association between household wealth and breastfeeding (BF) behavior throughout the development process of Asian countries. Our empirical investigations are based on 42 Demographic Health Surveys (DHS) conducted in 15 Asian countries with a large time window (1990-2017) to capture the diversity of development levels. We construct four indicators describing adequate BF practices (early initiation of BF, exclusive BF, continued BF at one year and two years) and a harmonized asset-based composite index of household wealth, allowing for comparison across DHS waves and countries. To highlight the dynamics of the wealth-BF association, we carry out econometric estimations, including interaction terms between household wealth and the country's level of economic development (low, medium, and high) or time. We also perform instrumental variable estimations aiming to limit suspected endogeneity issues. Our results confirm the existence of a transition in the wealth gradient of exclusive BF and continued BF in Asian countries. More precisely, while these practices are pro-poor in the poorest countries of the sample, they progressively spread to wealthier households along with the level of economic development. For exclusive BF, namely, this transition has resulted in a reversal of the wealth gradient at the end of the period (*i.e.*, exclusive BF prevalence among the rich overpassing that of the poor). We fail, however, to observe this kind of transition for early initiation of BF, this practice remaining pro-poor, whatever the level of economic development.

Keywords: Asia; breastfeeding; household wealth; economic development.

JEL: J13; J16; O15.

1. Introduction

Many infants and young children are not breastfed or breastfed inadequately, according to international recommendations (WHO and UNICEF, 2003). These recommendations include early initiation of breastfeeding (EIBF) within one hour after the birth, exclusive breastfeeding (EBF) for the first 6 months and continued breastfeeding (CBF) for up to 2 years (with adequate complementary foods). According to the most recent estimates made by the Global Breastfeeding Collective (WHO and UNICEF, 2018), the prevalence of EIBF, EBF and CBF reaches respectively 42%, 41% and 45% worldwide, which is well below the 2030 international targets (70%, 70% and 60%, respectively). In terms of dynamics, recent evidence shows that breastfeeding practices (BF) have increased in high-income countries since the beginning of the 21st century, whereas the trends are more contrasted in developing countries, depending on the BF indicator considered, the geographic zone and the level of development (Neves et al., 2020).

Suboptimal BF behavior (*i.e.*, that does not combine EIBF, EBF and CBF, in line with WHO and UNICEF recommendations) is becoming a major health concern on the global agenda. On the one hand, the public health literature has increasingly emphasized the different health costs of inadequate BF for infants and children (greater exposition to infectious diseases, increased probability of obesity and diabetes, and reduction in cognitive and non-cognitive skills) and for mothers (increased risks of post-partum depression, ovarian and breast cancer, heart disease and type-2 diabetes) (Belfield & Kelly, 2012; Girard et al., 2017; UNICEF, 2018). Nowadays, approximately 600,000 children and 100,000 women may die each year due to inadequate BF behaviors worldwide (Walters et al., 2019). It is worth noting, however, that the purported benefits of good BF practices on infant and child health remain debated in the recent empirical literature. In particular, experimental studies tend to find mixed results regarding the effects of BF on cognitive and non-cognitive development (*e.g.*, Kramer et al., 2007, 2008; Fitzsimons & Vera-Hernández, 2022). On the other hand, inadequate BF has long-term economic costs, especially reduced educational attainment and labor market outcomes in adulthood (*e.g.*, Fletcher, 2010; Cesur et al., 2017). Walters et al. (2019) estimate the global economic losses associated with not BF to be more than \$340.3 billion, accounting for approximately 0.7% of global gross national income (GNI). Hence, understanding the causes of optimal BF is crucial to designing effective long-term health policies.

Factors accounting for optimal BF practices are closely linked to the trade-off between breastfeeding and milk formula. This trade-off is first conditioned by the development of the milk formula market (*i.e.*, the "supply-side") and especially by changes in the distribution, affordability and marketing of milk substitutes (Baker et al., 2016; Rollins et al., 2016). It is also influenced by the "demand-side," mothers and their families comparing short-term opportunity costs and long-term health benefits associated with adequate BF, depending on the state of the supply side in the living area (Rippeyoung and Noonan, 2012). Finally, the BF vs. formula trade-off also depends on upstream factors such as access to safe water and healthcare, maternal employment and earnings, patterns of childbearing, psychological and cultural constraints against BF, access to information on BF benefits, and the existence of programs promoting BF (Rippeyoung and Noonan, 2012; Rollins et al., 2016). To sum up, adopting optimal BF practices is conditioned on a complex set of factors, combining supply- and demand-side determinants and macro- and micro-level determinants.

From an empirical perspective, many country-specific studies examine the effect of household (or mother) socio-economic status (SES) on adopting optimal BF behaviors, assuming that the BF vs. formula trade-off depends on income, education, wealth, and occupation. While interesting, these studies do not provide general conclusions about the dynamics of the SES-BF association. Moreover, they tend only to consider demand-side microeconomic factors and thus neglect potential macroeconomic determinants. Based on the idea that macro- and micro-level factors may jointly influence BF practices, another set of studies adopts a comparative cross-country approach and reveals strong between- and within-country wealth-related heterogeneity regarding BF practices.

First, this strand of the literature suggests that optimal BF prevalence is lower among the richest countries (WHO, 1981; Grummer-Strawn, 1996; Victora et al., 2016; UNICEF, 2018; Neves et al., 2020; Neves, Barros et al., 2021). For instance, Victora et al. (2016) show that with the exception of EIBF, the prevalence of all BF indicators tends to be lower among rich countries than in developing countries. Many macroeconomic factors account for this heterogeneity, including urbanization, workforce feminization, the medicalization of pregnancy and childbirth, affordability of milk formula and intensity of associated marketing practices (Grummer-Strawn, 1996; Neves et al., 2020).

Second, some of these cross-country studies also reveal that the wealth gradient of BF practices might depend on the level of a country's economic development (Neves, Barros et al., 2021; Neves et al., 2020; Victora et al., 2016). For instance, comparing 98 surveys from

low-income and middle-income countries and using mean and variance analyses, Victora et al. (2016) find that the poorest mothers of each country tend to breastfeed longer than richer mothers (*i.e.*, higher CBF), these results being fully confirmed by Neves et al. (2020). These authors consider that, in developing countries, constraints on access to safe water and low affordability of milk formula mainly explain the overrepresentation of CBF among the poorest individuals (even if psychological and cultural obstacles against BF persist). Conversely, as Volk & Franklin (2020) explain, richer women from developing countries tend to benefit from better affordability of formula milk since they usually live in the richest urban neighborhoods. Moreover, affluent families often use formula milk as a social signal to stand out from the poor and publicly demonstrate their wealth, prosperity and modernity. The situation observed in high-income countries tells an opposite story. Despite a lower prevalence of appropriate BF practices in these countries, there is evidence that richer and better-educated women tend to breastfeed more commonly and more adequately compared to under-privileged women (*e.g.*, Jones et al., 2011; Kohlhuber et al., 2008; Oakley et al., 2014; Sarki et al., 2019; Victora et al., 2016). This may be explained by the fact that in rich countries, the diffusion of information about BF benefits as well as the adoption of policies promoting and facilitating BF (maternity leaves, promotion campaigns, creation of BF rooms in the workplace, generalization of right to BF breaks, banning marketing and discounts for first-age formula milk, etc.) may first target wealthy mothers, thus explaining an increase in BF practices among the social elite. In a nutshell, the scarce previous comparative evidence points out the crucial role of the interaction between macro and micro drivers in explaining BF behavior. More specifically, it tends to suggest the existence of a socio-economic reversal in the wealth gradient of BF along with economic development, *i.e.*, where one country moves from low-income to lower middle-income, upper middle-income and high-income status. This reversal hypothesis has already been extensively explored and confirmed in the case of non-communicable diseases (NCDs) (*e.g.*, Dinsa et al., 2012; Pampel et al., 2012; Zhang et al., 2023). However, the evidence remains scarce regarding optimal BF practices.

Asian countries are particularly concerned about BF challenges (Lee and Binns, 2019; Torlesse and Raju, 2018; Walters et al., 2019, 2016). Torlesse & Raju (2018) observe that, although improvements were reached between 2000 and 2016 regarding EIBF, both EBF and CBF prevalence has only marginally increased. Given the demographic weight of Asia, the costs of not BF are particularly high in this region, accounting for approximately 37% of global economic losses, according to Walters et al. (2019). Paradoxically, except for Benedict et al. (2018), who provide partial comparative evidence for five countries from South Asia,

no systematic study analyzing between- and within-country wealth disparities in BF practices in Asia was published to our knowledge. Likewise, country-specific studies failed to provide clear results regarding the wealth-BF association in Asia (Bhandari et al., 2019; Chandhiok et al., 2015; Gayatri and Dasvarma, 2020; Hazir et al., 2013; Kounnavong et al., 2013; Ogbo et al., 2019; Rahman et al., 2020; Senarath et al., 2012; Um et al., 2020; Yadanar et al., 2020). This lack of clear evidence underscores the importance of conducting a cross-country comprehensive analysis at the Asian continent scale. Such a macro-regional overview allows going beyond country-specificities affecting BF practices (*e.g.*, perception of breastfeeding or characteristics of the milk-substitute market) and contributing to the complexity of the wealth-BF association. Based on this cross-country approach, we can also investigate whether and to what extent the association changes across time and countries' development levels.

This article aims to test the social reversal hypothesis in Asian countries and to provide robust econometric evidence on between- and within-country wealth-related disparities in BF practices. To do so, we rely on the combination of 42 Demographic and Health Surveys (DHS) waves covering 15 Asian countries with a large time window to test the existence of a reversal in the wealth-BF association throughout the development process. We construct four breastfeeding indicators (EIBF, EBF, CBP up to 1 and 2 years), asset-based composite indices of household wealth allowing for comparison across DHS waves and indicators of economic development. Based on linear and instrumental variables econometric estimations, our results for Asian countries confirm the existence of a transition in the wealth gradient of EBF and CBF in Asian countries. More precisely, while these practices are pro-poor (*i.e.*, more common among poor households) in the poorest countries of the sample, we emphasize a decrease in the negativity of their association with household wealth along with the level of economic development (*i.e.*, an increase in the prevalence for the rich and a decrease for the poor). For EBF, this transition has resulted in a reversal of the wealth gradient at the end of the period (*i.e.*, EBF prevalence among the rich surpassing that of the poor). We fail, however, to observe this kind of transition for EIBF, this practice remaining pro-poor, whatever the level of economic development.

This article has several major contributions. To the best of our knowledge, it is the first to econometrically demonstrate from a large sample of developing countries the occurrence of a shift in the wealth-BF association across levels of economic development. The existing cross-country literature on the topic mainly relies on descriptive statistics, mostly through variance decomposition analyses (*e.g.*, Victora et al., 2020; Nevel et al., 2020). While these studies are

undoubtedly valuable, they only inform about bivariate correlations between household socio-economic status, BF practices and development levels. Adopting an econometric multivariate approach allows to control for potential confounding factors (*i.e.*, important determinants of BF practices correlated with wealth) that could bias bivariate analyses. It also offers the possibility of carrying out endogeneity-correction methods to go beyond crude correlations and identify potential effects. Finally, econometric methods are well suited to explore the interactive effects of household wealth and development levels on BF practices more in-depth. Consequently, based on econometric tools, this article enriches the scant literature examining the influence of the interaction between macro- and micro-level factors on BF practices and provides interesting insights regarding the design of BF promotion policies.

The rest of the article is structured as follows. Section 2 describes the dataset and the construction of the variables of interest. The econometric methodology and the results are respectively presented in Sections 3 and 4. Section 5 concludes, discusses our main findings and provides policy recommendations.

2. Data and variables construction

2.1. Data and sample restrictions

This study is based on data from the Demographic and Health Surveys (DHS), collected through a collaboration between the United States Agency for International Development (USAID) and its technical partners, including ICF International. The main objectives of DHS data are to track demographic, health and nutrition patterns in developing countries to facilitate public health and development research and enable informed decision-making in these domains. The data provide a nationally representative snapshot of a wide range of population, health, and nutrition indicators collected from women aged 15-49 and their children under five. These data allow for comparing countries over time as the DHS program applied standard procedures and methodologies. In this study, we focus on data available for the Asian continent. As shown in Table A2.1 in the Appendix, we first compiled data from 62 DHS collected in 20 countries distributed across South Asia (6 countries), Europe & Central Asia (7 countries), and East Asia & the Pacific (7 countries), including low-income, lower-middle-income and upper-middle-income countries. However, due to data availability and comparability constraints for constructing our development level and household wealth indicators, we finally could pool 42 DHS covering 15 countries from 1990 to 2017. We argue

that the period and the number of countries covered are large enough to reflect a potential shift in the wealth gradient of BF practices according to different stages of development and time. After sample restrictions, the whole dataset is composed of 3,030,568 observations.

2.2. Outcome variables

Based on the WHO (2021) report, four indicators of optimal BF practices are considered and constructed in this study: (1) early initiation of breastfeeding (EIBF) is a dummy indicating whether children born in the past 24 months were put to the breast within an hour of birth; (2) exclusive breastfeeding (EBF) is a dummy indicating whether infants aged 0-5 months are fed exclusively with breastmilk; (3) continued breastfeeding at one year (CBF1) is a dummy indicating whether children aged 12-15 months are still fed with breast milk, and (4) continued breastfeeding at two years (CBF2) is a dummy indicating whether children aged 20-23 months are still fed with breast milk. Table A2.2 in the Appendix reports the sample means of the four BF indicators for each country and wave.

2.3. Construction of household wealth indices

To construct a standardized measure of household wealth, allowing comparison across countries and DHS waves, we employed a principal component analysis (PCA) to reduce multidimensional information into a composite index. Specifically, our synthetic index includes seven variables accounting for consumer durables ownership (radio, TV, refrigerator, bicycle, motorcycle, car, and phone), two variables describing access to public facilities (water and electricity), and three variables describing housing conditions (number of sleeping rooms, quality of floor material, and toilet facility). In this study, we primarily focused on the PCA-based wealth index because it is the most used in the related literature, but as robustness checks, we also considered a multiple component analysis (MCA) to calculate a comparable index (using the same core variables as for the PCA). More details about calculating the wealth index and related PCA and MCA approaches are available in Textbox A2.1 and Tables A2.3 to A2.7 in the Appendix. The sample means of the PCA-based wealth index for each country and wave can be found in Table A2.2 in the Appendix.

2.4. Construction of development-level categories

Another purpose of this study is to analyze how the association between BF practices and household wealth varies according to the level of development. Our initial idea was to use the

World Bank's classification of countries by income levels for each survey wave. Unfortunately, applied to our sample of Asian countries, this classification failed to capture enough heterogeneity in terms of stages of development, with too many Asian countries being classified into the upper-middle income group. Consequently, we decided to generate our own cutoffs based on the sample distribution. More specifically, we collected information on the GDP per capita in PPP (constant 2017 international \$), GNI per capita in PPP (constant 2017 international \$) and human development index (HDI) for each country and survey year from the World Development Indicators of the World Bank. Then, we split these three national development indicators into tercile groups (low, medium, and high), as shown in Table A2.8 in the Appendix (each DHS wave by country representing a statistical unit). We decided to keep the classification based on GNI per capita PPP (constant 2017 international \$) for the baseline analysis and used the other classification methods (with GDP and HDI) as robustness checks. The GNI-based category for country and wave is reported in Table A2.2 in the Appendix.

2.5. Control variables

The econometric models (defined below) include a comprehensive set of covariates that the literature has hypothesized to be important determinants of BF behaviors (Bhandari et al., 2019; Chandhiok et al., 2015; Gayatri and Dasvarma, 2020; Hazir et al., 2013; Kounnavong et al., 2013; Ogbo et al., 2019; Rahman et al., 2020; Senarath et al., 2012; Um et al., 2020; Yadanar et al., 2020). The infant's characteristics include sex, age (in months), birth order, birth interval (in months), size at birth (5-point score), and information about multiple births. Obstetric data include the wantedness of pregnancy, the number of antenatal visits, the mode of delivery (C-section or not), and the place of delivery (at home or not). The mother's characteristics include her age (in years), marital status (married or not), number of children and level of education (no education; primary; secondary; higher). In addition to the wealth index (see above), we include the place of residence (urban or rural) to account for household characteristics and control for dummies specific to each round of DHS surveys. We also considered alternative covariates only for robustness checks insofar as, due to various missing values, their introduction resulted in a significant loss of observations: mother's BMI (body mass index), mother's employment (yes or no), and religion (Muslim, Christian, Hindu, Buddhist, and others). Summary descriptive statistics for each covariate are reported in Table A2.9 in the Appendix.

3. Econometric framework

Using linear probability models estimated through OLS, our baseline models (Eq.1) separately regress the four BF practices (EIBF, EBF, CBF1, CBF2) a mother applied for a child i (BF_i) on the wealth index of a household j ($Wealth_j$), the category of economic development k (low, medium or high) a country belongs to (Dev_k), and a comprehensive set of covariates measured at the child level (X_i) and at the household level (X_j) recognized as important determinants of adopting or not a given BF behavior in the related literature (see previous subsection). We also include dummies for each round of DHS, taking into account the dynamics of BF practices during the period (ω_t).

$$BF_i = \beta_0 + \beta_1 Wealth_j + \beta_2 Dev_k + \beta_3 X_i + \beta_4 X_j + \omega_t + \varepsilon_i \quad [1]$$

Then, to investigate potential changes in the wealth-BF relationship across economic development stages, Eq.2 includes an interaction term between household wealth and economic development category (low vs. medium vs. high). This interaction model can be expressed as follows:

$$BF_i = \alpha_0 + \alpha_1 Wealth_j + \alpha_2 Dev_k + \alpha_3 Wealth_j * Dev_k + \alpha_4 X_i + \alpha_5 X_j + \omega_t + \mu_i \quad [2]$$

In an alternative OLS model, we also test potential differences in the evolution of BF behaviors across wealth groups and time. Specifically, we introduce as regressors interaction terms between the survey year (varying from 1990 to 2017) and household wealth index split into quintile groups (calculated from country- and time-specific subsamples).

Finally, we test the robustness of OLS estimates regarding the potential presence of endogeneity using an IV approach based on a two-stage least square (2SLS) estimation. Indeed, the wealth-BF association is assumed to be endogenous because of the potential omission of unobserved wealth determinants that also correlate with mothers' choices, such as mothers' employment status, occupation, and hours worked. One may assume, for instance, that unemployed or partial-time working mothers are more likely to adopt recommended BF behaviors but may also be concerned with lower household wealth accumulation. Hence, the overrepresentation of unemployed (or partially employed) women among low-wealth households may overstate the negative association between household wealth and the adoption of optimal BF behaviors. In practice, the 2SLS estimator works in two steps: step 1

regresses the household wealth index on the selected instruments and covariates; step 2 regresses BF indicators on fitted values of household wealth (from step 1) and covariates.

Identifying a relevant instrument is challenging, as it must satisfy two requirements: being a significant determinant of household wealth (relevance condition) and uncorrelated to unobserved variations of BF indicators (exogeneity condition). In the health economics literature, spatially aggregated socio-economic or demographic variables are commonly used to instrument household wealth since they are outside the control of individuals and households and thus may be treated as exogenous (Kim et al., 2010; Barnes et al., 2013; Kpelitse et al., 2014; Bonnefond & Clément, 2014; Clément, 2017; Daran & Levasseur, 2022). Based on this approach, we propose to instrument household wealth with the average height of mothers at the PSU level, excluding household i . In line with the literature, this instrument may be considered relevant as it is a metabolic driver of economic success: the tallest tend to be the wealthiest because a large proportion of them reached their full cognitive potential. In contrast, an important proportion of relatively more minor individuals did not reach it (Case and Paxson, 2008). The strength of the instrument is tested in the next section. Regarding the exogeneity condition, there is no reliable empirical test that we are able to implement. Nonetheless, one can reasonably assume that a mother does not choose to breastfeed or not breastfeed based on the average height of her community.

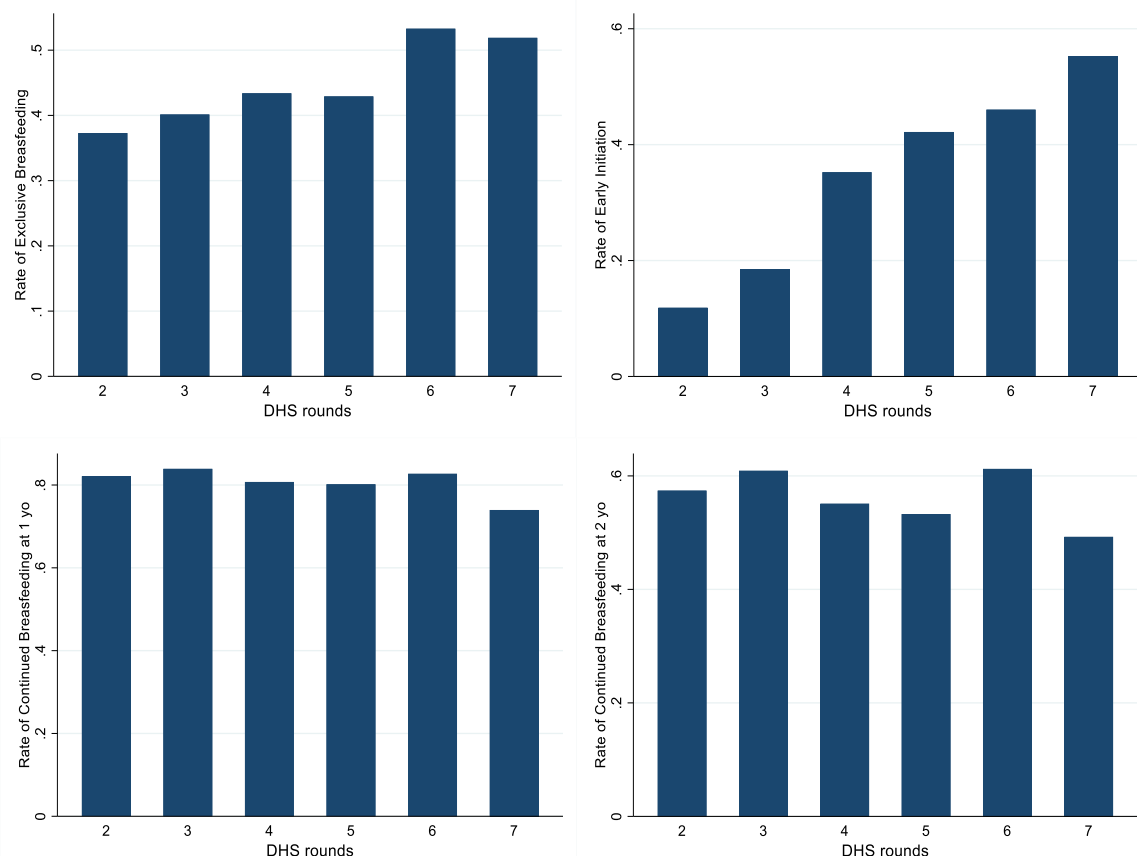
4. Results

4.1. Descriptive evidence

Figure 2.1 presents the dynamics of BF behaviors in Asia over time (*i.e.*, using DHS rounds). The rate of EIBF significantly improved in the region between round 2 (the early 1990s) and round 7 (late 2010s), increasing from 12% to 55%. We also observe an increase in the rate of EBF (from 38% to 52%), though to a lesser extent than EIBF. CBF (CBF1 and CBF2) that was already high in the early 1990s (above 80% for CBF1 and close to 60% for CBF2) slightly decreased over the period. Broadly speaking, our results align with previous estimates (*e.g.*, Torlesse & Raju, 2018).

To go further, Table 2.1 shows that both CBF rates tend to decline with the level of economic development (*i.e.*, higher rates observed in low-income countries), while the reverse is true for EIBF and EBF. Detailed statistics for the countries included in the sample can be found in Table A2.2 in the Appendix.

Figure 2.1: Rates of BF practices across DHS rounds.



Source: Authors from Asian DHS data (rounds 2 to 7).

Table 2.1: BF practices rates by groups of GNI/capita (\$PPP2017).

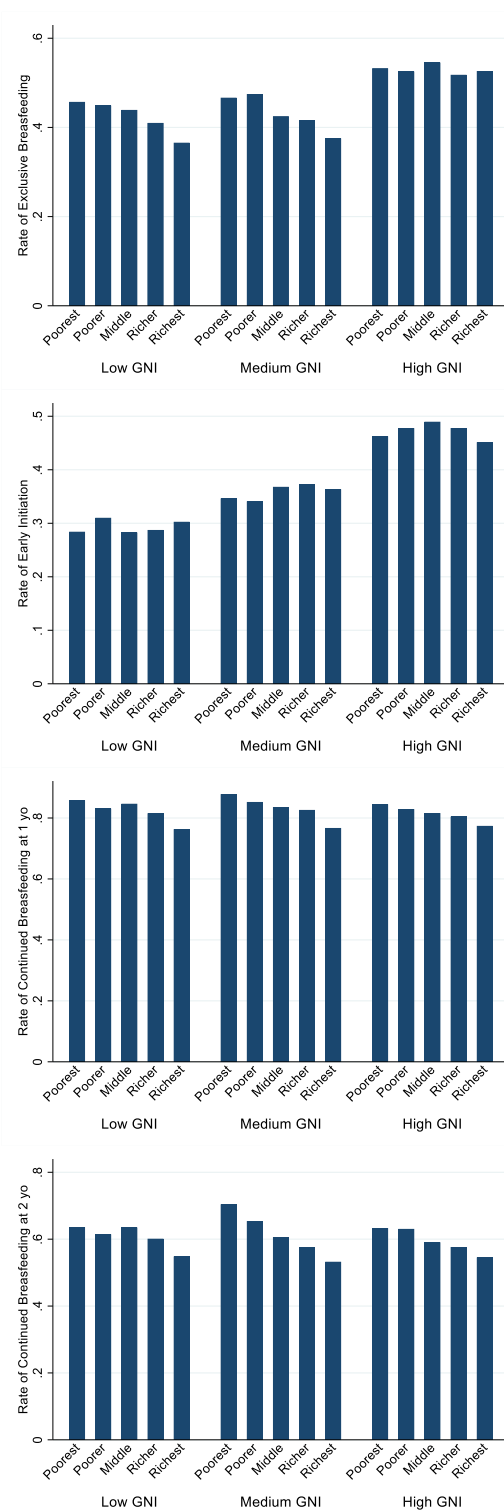
Groups of GNI/capita (\$PPP2017)	EBF	EIBF	CBF1	CBF2
Low	42.75%	25.11%	82.45%	60.09%
Medium	44.69%	38.50%	82.23%	59.52%
High	49.57%	48.37%	77.09%	54.52%
ALL	46.11%	38.33%	79.93%	57.22%

Source: Authors from Asian DHS data (rounds 2 to 7).

Then, to provide descriptive evidence on the association between BF behaviors, household wealth and economic development, Figure 2.2 presents graph bars of BF indicators across household wealth quintiles (specific to each country and period) and levels of GNI per capita (low, medium, and high). We observe a convergence process of BF practices across wealth quintiles and economic development. Put differently, household wealth-related disparities tend to be less pronounced in high-income countries compared to low- or medium-income countries. However, once again, we detect the presence of heterogeneity according to the BF indicator considered. For EBF, there is evidence of a negative association between the prevalence of such behaviors and household wealth in low-income countries and then a

decrease in the negativity of the association in high-income countries, indicating a process of catching up by the rich. For other BF indicators, the results are less clear.

Figure 2.2: Rates of BF practices by groups of household wealth (based on PCA quintiles) and GNI/capita (\$PPP2017).



Notes: Specific wealth quintiles are calculated for each country and survey year.

Source: Authors from Asian DHS data (rounds 2 to 7).

To sum up, all these findings suggest the existence of a transition in the BF-wealth association along with a country’s economic development, which could be different according to the BF indicator considered. This preliminary evidence calls for further inferential analysis.

4.2. Econometric evidence

Table 2.2 presents the baseline OLS estimates of Eq.1 and Eq.2 for each BF behavior considered (EBF, EIBF, CBF1 and CBF2). In these estimates, the PCA approach and the GNI per capita in \$PPP are used for computing the household wealth index (0-to-1 score) and the three categories of economic development (low, medium, and high). The corresponding full regression results (including control variables) are available in Table A2.10 in the Appendix.

Table 2.2: OLS regressions of BF practices on household wealth, GNI/capita (\$PPP2017), and covariates.

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo		Continued breastfeeding at 2 yo	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.144*** (0.019)	-0.366*** (0.031)	-0.097*** (0.011)	-0.100*** (0.020)	-0.137*** (0.017)	-0.169*** (0.030)	-0.164*** (0.022)	-0.247*** (0.040)
Medium GNI per capita (dummy)	-0.017 (0.011)	-0.088*** (0.021)	0.021** (0.008)	0.036*** (0.014)	-0.019* (0.010)	-0.022 (0.018)	-0.030** (0.014)	-0.015 (0.025)
High GNI per capita (dummy)	0.039*** (0.010)	-0.077*** (0.017)	0.064*** (0.007)	0.060*** (0.011)	-0.002 (0.009)	-0.020 (0.014)	-0.038*** (0.013)	-0.085*** (0.020)
Wealth*MediumGNI		0.208*** (0.052)		-0.046 (0.031)		0.008 (0.049)		-0.048 (0.062)
Wealth*HighGNI		0.336*** (0.036)		0.016 (0.023)		0.053 (0.034)		0.143*** (0.044)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Observations	34,452	34,452	133,506	133,506	25,449	25,449	21,890	21,890
R-squared	0.086	0.088	0.084	0.084	0.080	0.080	0.118	0.119
Children’s age interval (in months)	[0-5]	[0-5]	[0-23]	[0-23]	[12-15]	[12-15]	[20-23]	[20-23]

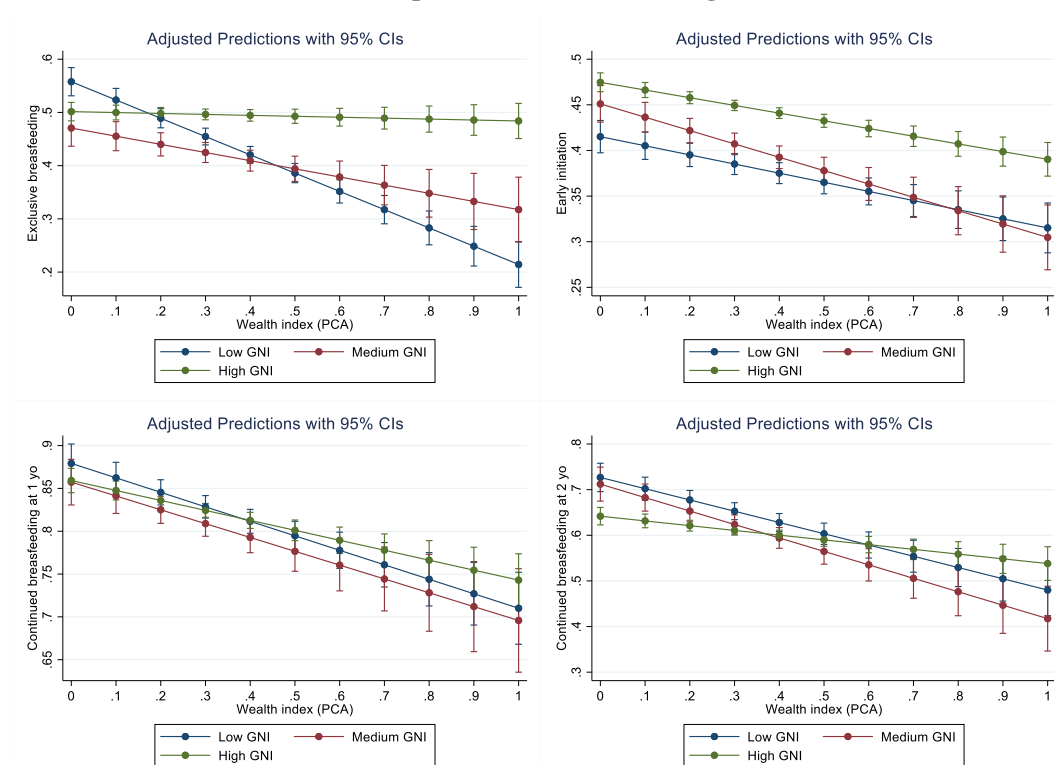
Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01, ** p<0.05, * p<0.1. Samples of children vary according to the dependent variable (see the line “age interval”). Control variables are: child sex, child age, child’s size at birth size, birth order, birth interval, multiple births, child wantedness by parents, number of antenatal visits, delivery place (at home or not), delivery mode (C-section or not), mother’s completed education, mother’s age, mother’s marital status, number of children in the household, the living place of the household (rural or urban), and dummies of DHS rounds (round 2 to 7).

Source: Authors from Asian DHS data (rounds 2 to 7).

OLS estimates of Eq.1 (linear specification) show negative associations between household wealth and each BF indicator, thus indicating that the adoption of adequate BF practices tends to decrease with household wealth. The results are particularly interesting when we refer to the interaction model specification (Eq.2), for which we plotted marginal effects in Figure 2.3. Based on this figure and Table 2.2, we observe a decrease in the negativity of the association of EBF and CBF with household wealth along with economic development (even though the interaction terms are not significant for CBF1). These results are important insofar as they provide evidence of a transition in the wealth gradient of these BF indicators when a country

shifts from low- to medium- and high-GNI status. More precisely, this transition is characterized by a rise in the prevalence of EBF and CBF among the rich (especially pronounced for EBF) and a decrease among the poor as the level of economic development increases. This indicates the occurrence of a process of social convergence of such BF practices. In contrast, this process is not observed for EIBF; this practice remains pro-poor, whatever the level of economic development.

Figure 2.3: Marginal effects of OLS regression of BF practices on household wealth interacted by the level of a GNI/capita (\$PPP2017) (including covariates).



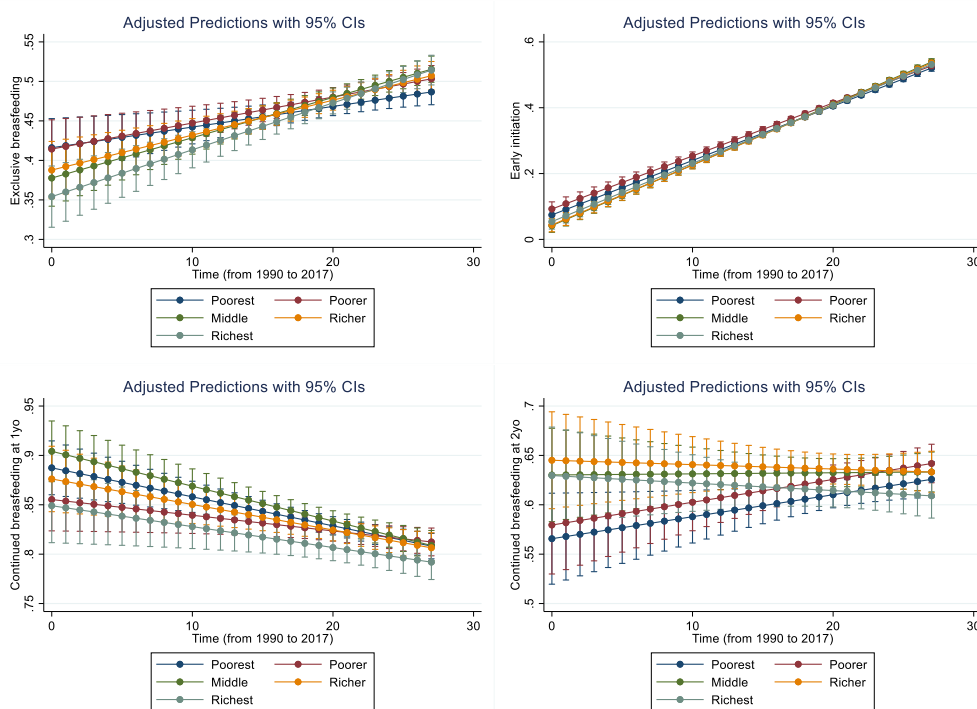
Notes: Dots refer to the marginal effects and brackets to standard errors. Full regression results are available in Table A2.10 in the Appendix. Samples of children vary according to the dependent variable (see Table 2.2 for age intervals). Control variables are: child sex, child age, child's size at birth, birth order, birth interval, multiple births, child wantedness by parents, number of antenatal visits, delivery place (at home or not), delivery mode (C-section or not), mother's completed education, mother's age, mother's marital status, number of children in the household, the living place of the household (rural or urban), and dummies of DHS rounds (round 2 to 7).

Source: Authors from Asian DHS data (rounds 2 to 7).

With the alternative OLS model including interaction terms between household wealth quintiles and survey years (from 1990 to 2017), we investigate potential temporal dynamics in the process of social convergence of BF practices. Fitted coefficients resulting from these estimates are presented in Figure 2.4 (full regression results in Table A2.11 in the Appendix). For EBF, we observe a clear reversal of the wealth-BF association across time. More precisely, while wealth inequality in EBF was substantial at the beginning of the period, with higher

rates observed among the poorest households, we note a social convergence in the 2000s driven by an increase in EBF prevalence greater among rich households than among poor households. As a result, wealth-related disparities slowly reversed during the 2010s, EBF becoming more prevalent among the wealthiest households. A quite similar process of catching-up of the rich throughout the period is also observed for EIBF. However, this process is less marked and more progressive since a reversal of the wealth gradient has not yet followed it, the rates of EIBF at the end of the period being very similar across wealth quintiles. For CBF2, we also emphasize a process of convergence but of a very different nature. Indeed, CBF2 was more prevalent among rich households at the beginning of the period. The catching-up of the poor thus characterizes the convergence process. Last, although Figure 2.4 suggests a certain converging trend across wealth groups for CBF1, these observed changes across time are not significant (Table A2.11).

Figure 2.4: Marginal effects of OLS regression of BF practices on household wealth quintiles interacted with time (including covariates).



Notes: Specific wealth quintiles are calculated for each country and survey year. Time refers to the survey year the data were collected and varies from year 0 (1990) to year 27 (2017). Dots refer to the fitted coefficients and brackets to standard errors at a 0.95% confidence level.

Full regression results are available in Table A2.11 of the Appendix. Samples of children vary according to the dependent variable (see Table 2.2 for age intervals).

Source: Authors from Asian DHS data (rounds 2 to 7).

Finally, we adopt an IV approach to limit endogeneity issues that could bias OLS estimates. More precisely, we perform 2SLS estimations using average mothers' height at the PSU level

(and its interacted declinations for the interaction model specification) as an instrument for household wealth. The results from first-stage regressions are available in Table A2.12 in the Appendix and confirm that our instrument is a good predictor of household wealth and thus satisfies the relevance condition, as shown by F-statistics and partial R-squared on the excluded instruments. IV regressions are summarized in Table 2.3 (full results in Table A2.13 in the Appendix). Broadly speaking, IV estimates are consistent with OLS estimates. First, the linear associations between household wealth and each BF indicator remain negative and significant. Second, when interacting with the household wealth classification and the level of a country's economic development (based on GNI per capita), IV regressions continue to suggest a social reversal for EBF and CBF2 along with the economic development level, this reversal being particularly meaningful for EBF. In contrast, as observed with OLS estimates, IV regressions fail to identify a significant social change in EIBF and CBF1 as a country develops.

Table 2.3: IV regressions (using area mothers' height at the PSU level as instruments).

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo		Continued breastfeeding at 2 yo	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.425*** (0.140)	-1.325** (0.517)	-0.575*** (0.079)	-0.293 (0.268)	-0.367*** (0.131)	-0.203 (0.419)	-1.165*** (0.168)	-2.381*** (0.605)
Medium GNI per capita (dummy)	0.025 (0.021)	-0.097 (0.153)	0.056*** (0.014)	0.199** (0.082)	-0.033 (0.021)	-0.040 (0.125)	-0.072*** (0.026)	-0.341** (0.168)
High GNI per capita (dummy)	0.052*** (0.019)	-0.322** (0.161)	0.078*** (0.012)	0.183** (0.085)	-0.020 (0.019)	0.054 (0.129)	-0.094*** (0.024)	-0.572*** (0.178)
Wealth*MediumGNI/c		0.471 (0.524)		-0.480* (0.283)		0.011 (0.427)		1.003* (0.601)
Wealth*HighGNI/c		1.268** (0.545)		-0.357 (0.288)		-0.248 (0.434)		1.658*** (0.628)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Number of instruments	1	3	1	3	1	3	1	3
Instruments	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c
Observations	22,788	22,788	92,849	92,849	16,817	16,817	15,153	15,153
Children's age interval (in months)	[0-5]	[0-5]	[0-23]	[0-23]	[12-15]	[12-15]	[20-23]	[20-23]

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01, ** p<0.05, * p<0.1. Samples of children vary according to the dependent variable. Control variables are : child sex, child age, child's size at birth, birth order, birth interval, multiple births, child wantedness by parents, number of antenatal visits, delivery place (at home or not), delivery mode (C-section or not), mother's completed education, mother's age, mother's marital status, number of children in the household, the living place of the household (rural or urban), and dummies of DHS rounds (round 2 to 7). Full results are available in Table A2.13 in the Appendix.

Source: Authors from Asian DHS data (rounds 3 to 7).

4.3. Robustness checks

Estimating Eq.1 and Eq.2 using alternative measures of household wealth (MCA approach instead of PCA approach) or development levels (GDP per capita in \$PPP and HDI instead of GNI per capita) tend to confirm our baseline results and provide even more significant evidence of the process of social convergence identified previously. More specifically, while OLS estimates in Table 2.2 only support the idea of a social convergence process along with economic development for EBF and CBF2 in high-income countries, several of these alternative estimates also emphasize such process for EIBF and CBF1. The complete results can be found in Tables A2.14, A2.15 and A2.16 in the Appendix.

We also carry out complementary econometric estimations of Eq.1 and Eq.2, including additional covariates that are important determinants of BF behaviors: mother's BMI, mother's employment, and religious affiliation dummies. We chose to exclude these control variables from previous estimates (Table 2.2) due to the drop in the number of observations it would have implied. These alternative estimates are reported in Table A2.17 in the Appendix. Despite the reduction in the number of observations, the findings remain consistent with Table 2.2. Nonetheless, looking at Table A2.17, one could be surprised to see a positive correlation between maternal employment and optimal BF behaviors, which differs from the literature results (Rivera-Pasquel et al., 2015). However, our maternal employment/unemployment indicator is imperfect since it measures the current employment status (*i.e.*, when the survey was collected) and not the employment status after birth. Consequently, this surprising result could simply reflect the fact that Asian women having access to work also tend to have better access to antenatal visits and hospitals for birth than women excluded from the labor market, and so the former might be more aware of BF-related information than the latter and more likely to breastfeed.

5. Discussion and conclusion

Based on a large sample of Asian countries and a large time window (1990-2017), this paper is the first to econometrically analyze the socio-economic drivers of optimal BF practices, considering conjointly micro- and macro-economic drivers. Specifically, OLS and IV approaches were combined to estimate potential changes in the relationship between household wealth (a synthetic 0-to-1 score measured with factorial methods) and several BF indicators (EBF, EIBF, CBF1, and CBF2) according to the stage of economic development a

country belongs to (low, medium, or high). We also carried out several robustness checks (alternative measures of household wealth and economic development of countries and additional covariates). Our investigations provide new insights into the socio-economic dynamics of BF practices and highlight interesting differences across BF indicators.

We emphasize a clear reversal in the wealth gradient of EBF characterized by the decrease of the negativity of the association between household wealth and EBF prevalence when one country moves from low- to medium- and high-income status. Put differently, this indicates that EBF tends to shift progressively from the poor to the rich along with economic development. A time-based analysis shows that this social reversal is characterized by a stronger increase in EBF prevalence for rich households than for poor households. As a result, EBF prevalence has become higher among the rich at the end of the period. Our results on EBF align with the cross-country study of Neves, Barros, et al. (2021), showing that, in countries from East Asia & Pacific and South Asia, the increase in EBF prevalence is higher among better-educated mothers. Some recent country-specific studies also confirm this trend, for instance, in Indonesia (Saputri et al., 2020) or India (Ghosh et al., 2022). The reversal in the wealth gradient of EBF might be driven by the implementation of baby-friendly hospital initiatives (namely including prenatal follow-ups and hospitalization of births) that have disproportionately contributed to reducing the use of pre-lacteal feeds among the richest households for whom this risky practice was widespread (Neves et al., 2021). There is increasing but still, limited evaluation literature assessing the implementation of such initiatives (*e.g.*, Walsh et al., 2023; World Bank, 2019) and their impact on BF behavior and infant and child health outcomes (*e.g.*, Pérez-Escamilla et al., 2016; Zhang et al., 2020). Conversely, the low increase in EBF observed among the poor across time and economic development is particularly worrying and should draw the attention of public health authorities. Several reasons may explain this tendency in Asia, including the increasing inclusion of poor women in the labor market and their strong sensitivity to formula milk marketing (Baker et al., 2016). Hence, future BF policies should specifically target poorer households by reducing opportunity costs associated with EBF through, for example, (i) the introduction of maternity leaves (or the increase in their duration and monetary compensations) for (low income) working women (Kottwitz et al., 2016; Navarro-Rosenblatt and Garmendia, 2018), (ii) the implementation of conditional cash transfers for unemployed women and/or vulnerable households (Powell-Jackson et al., 2015), and (iii) the provision of nursery and lactating rooms by the employers, especially in low-profile jobs in which such

facilities are often missing (Kim et al., 2019). In addition, implementing targeted promotion campaigns and regulating the formula milk market appear as necessary to limit the adoption of inappropriate BF practices among the poorest, and thus to avoid an increase in future health inequalities (Agampodi et al., 2021).

Our empirical investigations reveal similar trends, albeit less pronounced, for BF duration. Indeed, while CBF relatively remains a pro-poor practice in Asian countries with low and medium GNI, we observe a form of social convergence in CBF among Asian developing countries with higher GNI, especially for long CBF (*i.e.*, CBF2). This social homogenization in CBF across economic development might have the same drivers as discussed above for EBF, such as the implementation of pro-rich-oriented baby-friendly hospital initiatives, the entrance of poor women into the labor market, and the socially targeted marketing of the formula milk industry. However, one should note that CBF prevalence has decreased, contrary to EBF, which has increased during the period. If we take a step back, though, this fall is unsurprising. In fact, CBF is primarily recommended by the WHO in highly deprived contexts where breastmilk substitutes are potentially contaminated or of bad nutritional quality. CBF, especially CBF2, can therefore be considered less important for infant health in richer environments where clean water and baby food are accessible for all. This is probably why the WHO considers CBF2 as an optional indicator for assessing infant feeding practices rather than a core indicator (WHO, 2010).

Regarding EIBF, although this practice has highly increased over time, the wealth gradient does not significantly change along with economic development, remaining globally negative (*i.e.*, mostly a pro-poor practice). This result is once again consistent with Neves, Barros, et al. (2021), who observed a similar increase in EIBF among all educational groups. This generalized increase in EIBF among Asian populations may first be attributed to important improvements in prenatal follow-ups and a crude reduction in births at home (Doctor et al., 2019). Some authors like Sharma & Byrne (2016) also explain that BF acceptability has increased in South Asia in the last decades thanks to a decline in traditional cultural barriers (*e.g.*, religious-based and popular beliefs) combined with the empowerment of young women (*e.g.*, a lower influence of mother-in-law advice). Despite this generalized improvement in EIBF, the lower prevalence observed among richer households reflects a potential persistence of constraints limiting a more important diffusion of EIBF in Asian societies. According to the public health literature, the overuse of C-sections among the richest households in

developing countries might be one of these constraints (Roy et al., 2021); the proliferation of public and private C-sections negatively affecting EIBF (Li et al., 2021; Vaz et al., 2022). Consequently, regulating C-sections is likely to be a lever to reduce the social gap in EIBF in developing Asian countries.

To sum up, our results provide original evidence of the occurrence of a transition in the wealth gradient of BF practices along with economic development in Asia. For EBF, this transition has resulted in a reversal of the gradient (*i.e.*, EBF rates being higher among the rich at the end of the period). Based on our findings, we may also speculate that this reversal might occur shortly for CBF, as it is observed in high-income countries nowadays. By contrast, the future social distribution of EIBF is more uncertain and should be monitored.

Our results undoubtedly echo the literature exploring a reversal in the social gradient of NCDs, which emphasizes that the burden of obesity, diabetes, hypertension and cardiovascular diseases progressively shifts from higher-SES groups to lower-SES groups along with economic development, urbanization and globalization (*e.g.*, Dinsa et al., 2012; Jung et al., 2019; Pampel et al., 2012; Zhang et al., 2023). This literature provides interesting insights that help to understand better our results and their implications in terms of public policy. Indeed, this literature identifies several pathways that may also contribute to explaining the social reversal in BF practices. For instance, we can assume that the lack of health literacy and knowledge of public health recommendations among poorer and less educated individuals is a risk factor for both NCDs and inappropriate nutritional behaviors such as not BF (Hoffmann and Lutz, 2019). Further, it seems that both NCDs burden and inappropriate BF practices are directly connected, at least in the long run. As documented by the literature (*e.g.*, Horta et al., 2023; Stoodly et al., 2019; Victora et al., 2016), having been exposed to non-optimal BF practices at young ages increases the risk of NCDs in adulthood. Hence, the progressive shift of inappropriate BF practices from the rich to the poor may reinforce the prevalence of NCDs among the most vulnerable populations some decades later, generating a vicious circle. From a public health perspective, this means that promoting optimal BF practices, especially among underprivileged social groups, should be considered as a policy lever to fight against NCDs. Obviously, this work has some limitations. For instance, our sample does not include Asian high-income countries in the sense of the World Bank's classification, and so does not allow us to thoroughly test the social reversal hypothesis along with the process of economic development. Moreover, because of a lack of data, we do not control our estimates for supply-

side factors, like information on the formula milk market in the living area (*e.g.*, sales and market value). Despite such limitations, this work is a first step for future research that should focus on the transmission pathways between household socio-economic status and BF practices. Examining how maternal employment, BF policy interventions, formula market conditions, and changes in cultural norms may drive the wealth-BF gradient transition are important research avenues. Further, to better identify causality, we also encourage experimental and quasi-experimental impact assessments of baby-friendly hospital initiatives, labor reforms and social safety nets (*e.g.*, maternity leave and conditional cash transfers) on BF indicators, focusing on heterogeneous effects according to household socio-economic status.

Appendix

Table A2.1: List of countries and waves included in the study.

Countries	Region ^a	Classification by income level ^b	Years of surveys
Afghanistan	South Asia	LIC	2015
Armenia	Europe & Central Asia	LMIC	2000; 2005; 2010; 2015-2016
Azerbaijan	Europe & Central Asia	UMIC	2006
Bangladesh	South Asia	LMIC	1993-1994; 1996-1997; 1999-2000; 2004; 2007; 2011; 2014
Cambodia	East Asia & Pacific	LMIC	2000; 2005; 2010; 2014
India	South Asia	LMIC	1992-1993; 1998-1999; 2005-2006; 2015-2016
Indonesia	East Asia & Pacific	UMIC	1991; 1994; 1997; 2002-2003; 2007; 2012; 2017
Kazakhstan	Europe & Central Asia	UMIC	1995; 1999
Kirghizstan	Europe & Central Asia	LMIC	1997; 2012
Maldives	South Asia	UMIC	2009; 2016-2017
Myanmar	East Asia & Pacific	LMIC	2015-2016
Nepal	South Asia	LMIC	1996; 2001; 2006; 2011; 2016
Pakistan	South Asia	LMIC	1990-1991; 2006-2007; 2012-2013; 2017-2018
Papua New Guinea	East Asia & Pacific	LMIC	2016-2018
Philippines	East Asia & Pacific	LMIC	1998; 2003; 2008; 2012; 2017
Tajikistan	Europe & Central Asia	LIC	2012; 2017
Timor-Leste	East Asia & Pacific	LMIC	2009-2010; 2016
Turkey	Europe & Central Asia	UMIC	1993; 1998; 2003; 2008; 2013
Uzbekistan	Europe & Central Asia	LMIC	1996
Viet Nam	East Asia & Pacific	LMIC	1997; 2002

Notes: The waves of surveys highlighted in bold are those used in our final regressions.

(a) UNICEF definition; (b) World Bank FY21 analytical classification according to 2020 per capita GNI, calculated using the World Bank Atlas method. Lower-income countries (LIC) with per capita GNI of \$1,045 or less in 2020. Lower-middle income countries (LMIC) with per capita GNI between \$1,046 and \$4,095). Upper middle-income countries (UMIC) have a per capita GNI between \$4,096 and \$12,695.

Source: Authors.

Table A2.2: Sample means of BF practices and household wealth by country and survey wave.

COUNTRY	EBF	EIBF	CBF1	CBF2	Household wealth index (PCA)	Group of GNI/capita (\$PPP2017)
<i>DHS wave 2 (1990-1997)</i>						
India	0.38	0.12	0.85	0.61	NA	Low
Pakistan	0.28	0.09	0.76	0.54	0.29	Medium
Turkey	0.10	0.22	0.51	0.15	NA	High
Indonesia	0.45	NA	0.82	0.56	0.27	Low
<i>DHS wave 3 (1997-2001)</i>						
Bangladesh	0.44	0.16	0.90	0.84	0.11	Low
India	0.41	0.19	0.87	0.66	NA	Low
Kazakhstan	0.22	0.21	0.60	0.20	0.48	High
Kirgizstan	0.23	0.50	0.76	0.19	NA	Medium
Nepal	0.70	0.20	0.93	0.85	0.13	Low
Philippines	0.39	0.43	0.56	0.28	NA	High
Turkey	0.07	0.50	0.57	0.20	NA	High
Uzbekistan	0.04	0.22	0.72	0.37	0.46	Low
Vietnam	0.14	0.27	0.91	0.28	0.29	Low
Indonesia	0.40	0.08	0.85	0.61	0.27	Low
<i>DHS wave 4 (2001-2005)</i>						
Armenia	0.29	0.25	0.34	0.14	0.49	High
Bangladesh	0.40	0.26	0.92	0.84	0.15	Low
Cambodia	0.71	0.13	0.88	0.54	NA	Low
Nepal	0.60	0.33	0.96	0.85	0.12	Low
Philippines	0.29	0.54	0.59	0.29	NA	High
Turkey	0.20	0.51	0.61	0.25	NA	High
Vietnam	0.16	0.54	0.91	0.34	0.36	Medium
Indonesia	0.38	0.38	0.83	0.61	0.34	Low
<i>DHS wave 5 (2005-2010)</i>						
Armenia	0.32	0.33	0.46	0.17	0.52	High
Azerbaijan	0.09	0.30	0.34	0.14	0.39	Low
Bangladesh	0.42	0.43	0.93	0.84	0.21	Medium
Cambodia	0.64	0.53	0.82	0.46	NA	Low
India	0.43	0.32	0.86	0.62	0.31	Medium
Maldives	0.46	0.64	0.83	0.66	NA	Low
Nepal	0.50	0.35	0.95	0.85	0.19	Low
Pakistan	0.37	0.27	0.74	0.47	0.39	Medium
Philippines	0.35	0.54	0.59	0.30	NA	High
Timor-Leste	0.54	0.81	0.77	0.31	0.23	High
Turkey	0.27	0.49	0.68	0.25	NA	High
Indonesia	0.32	0.41	0.77	0.49	0.40	Low
<i>DHS wave 6 (2010-2016)</i>						
Armenia	0.44	0.40	0.42	0.20	0.57	High
Bangladesh	0.62	0.50	0.93	0.85	0.22	Medium
Cambodia	0.63	0.63	0.78	0.33	NA	Medium
India	0.55	0.44	0.85	0.65	0.32	High
Kirgizstan	0.58	0.84	0.65	0.25	NA	High
Nepal	0.66	0.49	0.89	0.84	0.25	Medium
Pakistan	0.40	0.27	0.71	0.41	0.37	Medium
Philippines	NA	0.54	0.57	0.35	NA	High
Tajikistan	0.34	0.51	0.71	0.39	0.42	Low
Turkey	0.28	0.63	0.69	0.30	NA	High
Indonesia	0.38	0.50	0.72	0.48	0.42	High
<i>DHS wave 7 (2016-2017)</i>						
Afghanistan	0.50	0.49	0.75	0.46	0.39	Low
Armenia	0.51	0.44	0.40	0.18	0.59	High
Maldives	0.62	0.71	0.84	0.65	NA	High
Myanmar	0.49	0.68	0.86	0.57	0.26	High
Nepal	0.69	0.58	0.95	0.84	0.23	Medium
Pakistan	0.52	0.29	0.69	0.44	0.40	High
Papua New Guinea	0.62	0.59	0.83	0.61	0.19	High
Philippines	NA	0.64	0.65	0.45	NA	High
Tajikistan	0.36	0.64	0.71	0.30	0.45	Medium
Timor-Leste	0.51	0.79	0.62	0.34	0.35	High
Indonesia	0.50	0.59	0.74	0.53	0.47	High

Source: Authors from Asian DHS data (rounds 2 to 7).

Textbox A2.1: Measuring household wealth.

One challenge of this study lies in constructing a harmonized household wealth index, allowing for comparison across countries and DHS waves. The DHS program already calculates a survey-specific composite index of household wealth, combining data on households' ownership of selected assets, such as televisions and bicycles, materials used for housing construction, and types of water access and sanitation facilities. Unfortunately, this index cannot directly be compared across countries and/or over time since its measurement is specific to each country and survey period (McKenzie, 2005). Hence, alternative strategies have been proposed in the literature. In particular, the strategy proposed by Smits & Steendijk (2015) has consisted of pooling 165 surveys (including DHS and further national household surveys) to identify a small set of assets common to a large set of surveys and avoid clustering observations around particular values. This index, known as the International Wealth Index (IWI), combines 12 asset-based variables. In addition to allowing for cross-country and -time comparison, the IWI is highly correlated with the DHS household wealth index and then can be considered as a robust alternative. In this study, we employed the same procedure with some adjustments in selecting variables from the original IWI according to the availability of information in the 42 DHS waves we merged. More precisely, our composite wealth index includes seven variables accounting for consumer durables ownership (radio, TV, refrigerator, bicycle, motorcycle, car, and phone), two variables describing access to public facilities (water and electricity), and three variables describing housing conditions (number of sleeping rooms, quality of floor material, and toilet facility). For categorical variables such as quality of water supply, floor materials, and toilet facility, we created three categories: (1) low quality, (2) medium quality, and (3) high quality. We added an "others" category if a doubt persists regarding the relevant category. As for the number of sleeping rooms, we created a three-category variable: (1) zero or one sleeping room, (2) two sleeping rooms, and (3) three or more sleeping rooms.

Another point we must address is handling the high proportion of missing values in some variables composing our wealth index. Indeed, several variables (mainly those referring to housing conditions and access to public facilities) were not collected in some DHS waves (reducing our whole sample size by 1.5% to 30%, depending on the variable). To limit this important loss of observations while neutralizing the influence of these missings on the calculation of the wealth index, we systematically replaced the missing values of each wealth-related variable with its PSU-based median value calculated on all waves available for a given country. Then, we carried out a rounding to the unit above for all non-integer values obtained (as 0.5 for dummy variables) to perform Principal Component Analysis (PCA) (see below). Descriptive statistics on the set of variables selected to construct our composite wealth indices are reported in Table A2.3 in the Appendix.

The construction of a composite household wealth index requires the use of an aggregation technique to allocate data-driven weights to the selected variables. PCA is the most popular method used in the literature to construct composite indices of household socio-economic status (Filmer & Pritchett, 1999, 2001). PCA is a data reduction technique in which several correlated variables are transformed into a smaller set of uncorrelated variables called principal components. Each principal component is a weighted linear combination of original variables. A composite index can be calculated by linearly combining low-order principal components (at least one), depending on their contribution to the total information. We performed a standard PCA to construct our first wealth index. Based on the criterion of eigenvalues greater than (or very close) to 1, we select the first ten components, accounting for 72.70% of the total variance, as reported in Tables A2.4 and A2.5 in the Appendix. In fact, many scholars have pointed out the methodological limitations of PCA applied to dummy or categorical variables (Howe et al., 2012; Poirier et al., 2020). MCA is a long-standing alternative to PCA, based on a similar methodology and specifically dedicated to categorical variables. We construct our second asset-based composite index of household wealth with this method. More precisely, we used the Burt method, which performs a correspondence analysis of the Burt matrix (a matrix of the two-way cross-tabulations of all pairs of variables). Results from this MCA procedure are presented in Tables S6 and S7. Although the first dimension resulting from MCA accounts for more than 88.74% of the total variance, we also included the second dimension in the index calculation to have a two-dimensional picture of wealth. These first two dimensions account for 90.76% of the information, which is much more satisfying than PCA. For both PCA and MCA-based wealth indices, we used standardized values following a normal distribution, bounded between 0 and 1.

Although a theoretical difference exists between PCA and MCA procedures, they do not differ in practice and are highly correlated. Booyesen et al. (2008) demonstrated that despite some differences in variable weight orders, no significant difference exists between wealth indices constructed from these two methods. Our data confirm the strong correlation between both indices (correlation coefficient equal to 0.93). Thus, we focus on the PCA-based wealth index because it is the most used in the related literature and considers the MCA-based as a robustness check.

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Table A2.3: Wealth index constitutive assets.

	Mean	Std. Dev.
Consumer durables		
Radio	0.301	0.459
Television	0.523	0.499
Refrigerator	0.238	0.426
Bicycle	0.434	0.496
Motorcycle/ Scooter	0.264	0.441
Car / Truck	0.066	0.249
Phone	0.068	0.252
Housing characteristics		
Floor material:		
<i>Low quality</i>	0.349	0.477
<i>Medium quality</i>	0.162	0.368
<i>High quality</i>	0.489	0.500
Toilet facility:		
<i>Low quality</i>	0.456	0.498
<i>Medium quality</i>	0.142	0.349
<i>High quality</i>	0.397	0.489
<i>Others</i>	0.004	0.066
The number of rooms:		
<i>Zero or one</i>	0.286	0.452
<i>Two</i>	0.438	0.496
<i>Three or more</i>	0.276	0.447
Public utilities		
Access to electricity:		
<i>Low quality</i>	0.392	0.488
<i>Medium quality</i>	0.359	0.480
<i>High quality</i>	0.242	0.428
<i>Others</i>	0.007	0.081

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.4: Results from PCA.

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.445	2.614	0.202	0.202
Comp2	1.830	0.285	0.083	0.285
Comp3	1.547	0.075	0.070	0.355
Comp4	1.472	0.112	0.066	0.422
Comp5	1.360	0.166	0.061	0.484
Comp6	1.193	0.109	0.054	0.538
Comp7	1.083	0.018	0.049	0.587
Comp8	1.065	0.054	0.048	0.636
Comp9	1.011	0.008	0.046	0.682
Comp10	1.002	0.030	0.045	0.727

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.5: Principal components (eigenvalues) from PCA.

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8	Comp9	Comp10	Unexplained
Electricity	0.268	0.116	-0.101	-0.056	0.094	-0.189	0.107	0.293	0.046	0.054	0.472
Radio	0.084	-0.216	0.219	0.147	0.096	0.185	-0.073	0.156	-0.080	0.068	0.682
TV	0.329	0.071	-0.051	0.007	0.040	-0.129	0.092	0.276	0.052	0.037	0.389
Refrigerator	0.319	0.091	-0.022	0.067	-0.077	0.176	0.127	-0.001	0.050	-0.017	0.459
Bicycle	0.018	0.106	-0.027	0.255	0.318	-0.088	0.082	0.417	-0.092	-0.231	0.480
Motorcycle	0.247	0.099	0.009	0.146	0.173	-0.031	-0.070	0.133	0.005	-0.077	0.606
Car	0.173	0.030	0.168	0.146	-0.068	0.341	0.205	0.051	0.121	0.099	0.571
Natural floor	-0.345	0.056	0.002	0.050	0.050	0.222	0.303	-0.202	-0.040	-0.179	0.222
Rudimentary floor	0.002	-0.123	0.069	0.093	-0.614	-0.028	-0.423	0.444	-0.053	-0.125	0.016
Finished floor	0.336	0.026	-0.047	-0.110	0.353	-0.198	-0.018	-0.094	0.074	0.256	0.181
Telephone	0.174	-0.021	0.032	0.081	-0.118	0.421	0.184	0.116	0.032	0.086	0.563
Low (toilet)	-0.304	0.171	-0.032	-0.037	0.220	0.359	-0.054	0.343	0.108	0.219	0.124
Middle (toilet)	-0.037	-0.337	0.217	0.091	-0.247	-0.475	0.530	0.033	0.109	0.094	0.022
High (toilet)	0.329	0.086	-0.132	-0.027	-0.033	0.001	-0.280	-0.343	-0.222	-0.378	0.071
Others (toilet)	-0.008	-0.053	0.036	-0.021	-0.030	-0.055	-0.380	-0.142	0.240	0.636	0.347
Low (water)	-0.223	0.350	-0.091	0.481	-0.002	-0.245	-0.076	-0.023	-0.020	0.078	0.117
Middle (water)	-0.015	-0.485	0.259	-0.365	0.301	0.058	-0.119	0.131	-0.093	-0.151	0.076
High (water)	0.270	0.106	-0.167	-0.164	-0.316	0.219	0.229	-0.105	-0.035	0.136	0.292
Others (water)	0.012	0.007	-0.013	-0.027	0.006	0.012	-0.090	-0.041	0.900	-0.384	0.020
0 or 1 room	-0.128	0.364	-0.033	-0.548	-0.115	-0.120	0.082	0.197	-0.020	-0.016	0.157
Two rooms	0.002	-0.458	-0.558	0.275	0.064	0.084	-0.000	-0.011	0.027	0.036	0.008
Three or more rooms	0.123	0.147	0.648	0.236	0.043	0.025	-0.080	-0.182	-0.010	-0.023	0.116

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.6: Results from MCA.

Dimension	Percent	Cumul percent
Dim 1	88.74	88.74
Dim 2	02.01	90.76
Dim 3	00.49	91.24
Dim 4	00.21	91.45
Dim 5	00.00	91.46
Dim 6	00.00	91.46
Total	100.00	100.00

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.7: MCA's statistics for row and column categories in symmetric normalization.

Categories	Overall			Dimension_1			Dimension_2		
	mass	quality	%inert	coord	sqcorr	contrib	coord	sqcorr	contrib
Electricity									
No	0.020	0.906	0.079	2.021	0.897	0.080	1.317	0.009	0.034
Yes	0.064	0.906	0.025	-0.624	0.897	0.025	-0.407	0.009	0.011
Radio									
No	0.063	0.791	0.004	0.191	0.517	0.002	-0.921	0.274	0.053
Yes	0.021	0.791	0.012	-0.583	0.517	0.007	2.817	0.274	0.163
TV									
No	0.039	0.890	0.084	1.475	0.889	0.084	0.406	0.002	0.006
Yes	0.045	0.890	0.072	-1.274	0.889	0.073	-0.351	0.002	0.006
Refrigerator									
No	0.064	0.908	0.035	0.745	0.908	0.035	0.106	0.000	0.001
Yes	0.020	0.908	0.111	-2.395	0.908	0.113	-0.340	0.000	0.002
Bicycle									
No	0.046	0.270	0.003	0.120	0.183	0.001	0.547	0.087	0.014
Yes	0.037	0.270	0.004	-0.151	0.183	0.001	-0.691	0.087	0.018
Motorcycle									
No	0.059	0.947	0.025	0.675	0.944	0.027	0.248	0.003	0.004
Yes	0.024	0.947	0.061	-1.633	0.944	0.065	-0.601	0.003	0.009
Car									
No	0.078	0.947	0.003	0.206	0.939	0.003	-0.128	0.008	0.001
Yes	0.006	0.947	0.043	-2.839	0.939	0.045	1.760	0.008	0.017
Telephone									
No	0.078	0.957	0.003	0.207	0.946	0.003	-0.146	0.011	0.002
Yes	0.006	0.957	0.042	-2.794	0.946	0.045	1.972	0.011	0.022
Floor									
Natural	0.032	0.917	0.077	1.566	0.915	0.079	-0.445	0.002	0.006
Rudimentary	0.010	0.477	0.002	-0.052	0.010	0.000	2.355	0.467	0.056
Finished	0.041	0.917	0.059	-1.219	0.916	0.061	-0.233	0.001	0.002
Water									
Low	0.038	0.913	0.028	0.854	0.881	0.027	-1.086	0.032	0.044
Middle	0.024	0.675	0.005	0.216	0.185	0.001	2.332	0.490	0.133
High	0.021	0.933	0.064	-1.796	0.930	0.067	-0.748	0.004	0.012
Other	0.000	0.776	0.000	-0.604	0.685	0.000	-1.467	0.092	0.001
Toilet									
Low	0.034	0.930	0.055	1.300	0.919	0.057	-0.956	0.011	0.031
Middle	0.013	0.758	0.007	0.387	0.262	0.002	3.543	0.497	0.164
High	0.036	0.940	0.063	-1.354	0.938	0.066	-0.441	0.002	0.007
Other	0.000	0.631	0.001	0.653	0.294	0.000	4.644	0.337	0.009
Sleeping rooms									
Zero or one	0.022	0.888	0.017	0.802	0.741	0.014	-2.369	0.147	0.126
Two	0.037	0.556	0.001	0.017	0.009	0.000	0.910	0.547	0.031
Three or more	0.024	0.884	0.015	-0.785	0.863	0.015	0.807	0.021	0.015

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.8: Distribution of observations across development-level categories.

	Low		Middle		High	
	Obs.	Percent	Obs.	Percent	Obs.	Percent
GDP per capita. PPP (Constant 2017 international \$)	1.242.939	30.10%	2.199.594	53.26%	687.264	16.64%
GNI per capita. PPP (Constant 2017 international \$)	1.494.969	36.20%	624.663	15.13%	2010.165	48.67%
HDI (Year of the survey)	1.094.021	26.49%	2.558.889	61.96%	476.887	11.55%

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.9: Descriptive statistics of covariates in the sample of children aged 0 to 5 months.

Covariates	Obs	Mean	Std. Dev.	Min	Max
Child is a male (dummy)	34,452	0.52	0.50	0	1
Child age (in months)	34,452	2.78	1.59	0	5
Childbirth size (5-point score)	34,452	2.94	0.79	1	5
Birth order	34,452	3.42	1.81	2	15
Birth interval (in months)	34,452	43.64	27.82	10	302
Multiple births (dummy)	34,452	0.01	0.10	0	1
Wanted child (dummy)	34,452	0.75	0.43	0	1
Number of antenatal visits	34,452	3.92	3.65	0	16
Delivery at home (dummy)	34,452	0.44	0.50	0	1
C-section delivery (dummy)	34,452	0.09	0.29	0	1
Uneducated mother (dummy)	34,452	0.35	0.48	0	1
Primary maternal education (dummy)	34,452	0.23	0.42	0	1
Secondary maternal education (dummy)	34,452	0.36	0.48	0	1
Tertiary maternal education (dummy)	34,452	0.07	0.25	0	1
Mother's age (in years)	34,452	27.99	5.57	15	49
Married (dummy)	34,452	0.99	0.12	0	1
Number of children	34,452	3.15	1.62	1	14
Living urban areas (dummy)	34,452	0.27	0.44	0	1
DHSwave2 (dummy)	34,452	0.05	0.21	0	1
DHSwave3 (dummy)	34,452	0.11	0.31	0	1
DHSwave4 (dummy)	34,452	0.05	0.22	0	1
DHSwave5 (dummy)	34,452	0.09	0.29	0	1
DHSwave6 (dummy)	34,452	0.51	0.50	0	1
DHSwave7 (dummy)	34,452	0.19	0.39	0	1
Mother is working (dummy)	20,336	0.24	0.43	0	1
Mother's BMI (kg/m ²)	20,074	21.46	3.60	12.16	58.96
Muslim (dummy)	25,052	0.34	0.47	0	1
Christian (dummy)	25,052	0.16	0.36	0	1
Hindu (dummy)	25,052	0.47	0.50	0	1
Bouddhist (dummy)	25,052	0.01	0.11	0	1
Others (dummy)	25,052	0.03	0.16	0	1
Area clean cooking fuel use (%)	33,999	0.34	0.39	0	1
Area mothers' height (in meters)	22,788	1.52	0.06	1.305	1.844

Source: Authors from Asian DHS data (rounds 2 to 7), regression sample of children aged 0 to 5 months when exclusive breastfeeding (EBF) is considered as the dependent variable.

Table A2.10: OLS regressions of BF practices on household wealth (calculated with a PCA approach), GNI/capita and covariates.

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo (dummy)		Continued breastfeeding at 2 yo (dummy)	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.144*** (0.019)	-0.366*** (0.031)	-0.097*** (0.011)	-0.100*** (0.020)	-0.137*** (0.017)	-0.169*** (0.030)	-0.164*** (0.022)	-0.247*** (0.040)
Medium GNI per capita (dummy)	-0.017 (0.011)	-0.088*** (0.021)	0.021** (0.008)	0.036*** (0.014)	-0.019* (0.010)	-0.022 (0.018)	-0.030** (0.014)	-0.015 (0.025)
High GNI per capita (dummy)	0.039*** (0.010)	-0.077*** (0.017)	0.064*** (0.007)	0.060*** (0.011)	-0.002 (0.009)	-0.020 (0.014)	-0.038*** (0.013)	-0.085*** (0.020)
Wealth*MediumGNI		0.208*** (0.052)		-0.046 (0.031)		0.008 (0.049)		-0.048 (0.062)
Wealth*HighGNI		0.336*** (0.036)		0.016 (0.023)		0.053 (0.034)		0.143*** (0.044)
Child is a male (dummy)	-0.015*** (0.005)	-0.015*** (0.005)	-0.005* (0.003)	-0.005* (0.003)	-0.002 (0.005)	-0.002 (0.005)	0.028*** (0.006)	0.027*** (0.006)
Child age (in months)	-0.080*** (0.002)	-0.080*** (0.002)	0.000 (0.000)	0.000 (0.000)	-0.004* (0.002)	-0.004* (0.002)	-0.021*** (0.003)	-0.021*** (0.003)
Childbirth size (5-point score)	-0.009*** (0.003)	-0.010*** (0.003)	-0.017*** (0.002)	-0.017*** (0.002)	-0.017*** (0.003)	-0.017*** (0.003)	-0.011*** (0.004)	-0.011*** (0.004)
Birth order	-0.034*** (0.004)	-0.035*** (0.004)	-0.004** (0.002)	-0.005** (0.002)	-0.070*** (0.004)	-0.070*** (0.004)	0.005 (0.005)	0.004 (0.005)
Birth interval (in months)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Multiple births (dummy)	-0.219*** (0.024)	-0.219*** (0.024)	-0.050*** (0.014)	-0.050*** (0.014)	-0.405*** (0.021)	-0.405*** (0.021)	-0.195*** (0.023)	-0.195*** (0.023)
Wanted child (dummy)	-0.000 (0.007)	0.001 (0.007)	0.043*** (0.004)	0.043*** (0.004)	0.018** (0.008)	0.018** (0.008)	0.002 (0.010)	0.003 (0.010)
Number of antenatal visits	-0.002** (0.001)	-0.001 (0.001)	0.004*** (0.000)	0.004*** (0.000)	-0.012*** (0.001)	-0.012*** (0.001)	-0.027*** (0.001)	-0.027*** (0.001)
Delivery at home (dummy)	0.026*** (0.007)	0.021*** (0.007)	-0.007* (0.004)	-0.008* (0.004)	-0.008 (0.006)	-0.009 (0.006)	-0.025*** (0.008)	-0.029*** (0.008)
C-section delivery (dummy)	0.002 (0.010)	-0.006 (0.010)	-0.184*** (0.005)	-0.184*** (0.005)	0.011 (0.009)	0.009 (0.009)	0.025** (0.012)	0.021* (0.012)
Primary maternal education (dummy)	-0.019** (0.008)	-0.021*** (0.008)	0.045*** (0.004)	0.045*** (0.004)	0.029*** (0.006)	0.029*** (0.006)	0.003 (0.009)	0.002 (0.009)
Secondary maternal education (dummy)	-0.012 (0.008)	-0.015** (0.008)	0.089*** (0.004)	0.088*** (0.004)	0.016** (0.006)	0.016** (0.006)	-0.015* (0.009)	-0.017* (0.009)
Tertiary maternal education (dummy)	0.002 (0.013)	-0.010 (0.013)	0.076*** (0.007)	0.075*** (0.007)	-0.013 (0.013)	-0.015 (0.013)	-0.063*** (0.015)	-0.068*** (0.015)
Mother's age (in years)	-0.003*** (0.001)	-0.003*** (0.001)	0.001** (0.000)	0.001** (0.000)	-0.002*** (0.001)	-0.002*** (0.001)	0.001 (0.001)	0.001 (0.001)
Married (dummy)	0.025 (0.023)	0.018 (0.023)	-0.064*** (0.011)	-0.064*** (0.011)	0.077*** (0.020)	0.076*** (0.020)	0.057** (0.024)	0.053** (0.024)
Number of children	0.041*** (0.005)	0.043*** (0.005)	0.006** (0.002)	0.006** (0.002)	0.083*** (0.005)	0.084*** (0.005)	-0.011** (0.005)	-0.010* (0.005)
Living urban areas (dummy)	-0.040*** (0.007)	-0.040*** (0.007)	-0.012*** (0.004)	-0.012*** (0.004)	-0.033*** (0.006)	-0.032*** (0.006)	-0.015* (0.008)	-0.015* (0.008)
DHSwave3	0.008 (0.017)	-0.006 (0.017)	-0.007 (0.014)	-0.005 (0.014)	0.054*** (0.014)	0.052*** (0.014)	0.069*** (0.021)	0.066*** (0.021)
DHSwave4	0.033* (0.018)	0.031* (0.018)	0.247*** (0.015)	0.248*** (0.015)	0.054*** (0.015)	0.054*** (0.015)	0.099*** (0.024)	0.098*** (0.024)
DHSwave5	0.007 (0.017)	0.024 (0.017)	0.323*** (0.013)	0.325*** (0.013)	-0.006 (0.015)	-0.003 (0.015)	-0.003 (0.022)	0.004 (0.022)
DHSwave6	0.077*** (0.016)	0.095*** (0.016)	0.279*** (0.011)	0.280*** (0.011)	0.036*** (0.014)	0.038*** (0.014)	0.148*** (0.022)	0.152*** (0.022)
DHSwave7	0.112*** (0.016)	0.125*** (0.016)	0.398*** (0.012)	0.399*** (0.012)	-0.036*** (0.014)	-0.033** (0.014)	0.022 (0.022)	0.026 (0.022)
Constant	0.746*** (0.035)	0.818*** (0.036)	0.141*** (0.021)	0.141*** (0.022)	0.924*** (0.041)	0.934*** (0.042)	1.100*** (0.074)	1.128*** (0.074)
Observations	34,452	34,452	133,506	133,506	25,449	25,449	21,890	21,890
R-squared	0.086	0.088	0.084	0.084	0.080	0.080	0.118	0.119

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01 ** p<0.05 * p<0.1.

Source: Authors from Asian DHS data (rounds 2 to 7), regression sample of children aged 0 to 5 months.

Table A2.11: OLS regressions of BF practices on household wealth (quintiles) interacted with time (and covariates).

Dependent outcome:	Exclusive breastfeeding (dummy)	Early initiation (dummy)	Continued breastfeeding at 1yo (dummy)	Continued breastfeeding at 2yo (dummy)
Time from 1990 to 2017 (in years)	0.003*** (0.001)	0.017*** (0.001)	-0.003*** (0.001)	0.002** (0.001)
Q2 of wealth (dummy)	-0.002 (0.023)	0.018 (0.012)	-0.032* (0.018)	0.014 (0.030)
Q3 of wealth (dummy)	-0.038* (0.022)	-0.033*** (0.012)	0.017 (0.018)	0.065** (0.028)
Q4 of wealth (dummy)	-0.028 (0.023)	-0.031** (0.012)	-0.011 (0.019)	0.079*** (0.030)
Q5 of wealth (dummy)	-0.062** (0.024)	-0.020 (0.013)	-0.038* (0.022)	0.064** (0.030)
Time*Q2	0.001 (0.001)	-0.000 (0.001)	0.001 (0.001)	0.000 (0.001)
Time*Q3	0.002** (0.001)	0.002*** (0.001)	-0.001 (0.001)	-0.002 (0.001)
Time*Q4	0.002* (0.001)	0.002*** (0.001)	0.000 (0.001)	-0.003** (0.001)
Time*Q5	0.003*** (0.001)	0.001* (0.001)	0.001 (0.001)	-0.003** (0.001)
Child is a male (dummy)	-0.015*** (0.005)	-0.005** (0.003)	-0.002 (0.005)	0.027*** (0.006)
Child age (in months)	-0.080*** (0.002)	-0.000 (0.000)	-0.004** (0.002)	-0.020*** (0.003)
Childbirth size (5-point score)	-0.009** (0.003)	-0.017*** (0.002)	-0.016*** (0.003)	-0.010** (0.004)
Birth order	-0.032*** (0.004)	-0.003 (0.002)	-0.069*** (0.004)	0.007 (0.005)
Birth interval (in months)	0.001*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.002*** (0.000)
Multiple births (dummy)	-0.220*** (0.024)	-0.053*** (0.014)	-0.402*** (0.021)	-0.179*** (0.023)
Wanted child (dummy)	-0.004 (0.007)	0.051*** (0.004)	0.007 (0.008)	-0.012 (0.010)
Number of antenatal visits	-0.003*** (0.001)	0.005*** (0.000)	-0.013*** (0.001)	-0.028*** (0.001)
Delivery at home (dummy)	0.032*** (0.007)	0.011*** (0.004)	-0.004 (0.006)	-0.020** (0.008)
C-section delivery (dummy)	-0.004 (0.010)	-0.195*** (0.005)	0.010 (0.010)	0.027** (0.012)
Primary maternal education (dummy)	-0.024*** (0.008)	0.047*** (0.004)	0.028*** (0.007)	-0.006 (0.009)
Secondary maternal education (dummy)	-0.029*** (0.008)	0.080*** (0.004)	0.011* (0.006)	-0.032*** (0.009)
Tertiary maternal education (dummy)	-0.027** (0.013)	0.060*** (0.007)	-0.031** (0.013)	-0.096*** (0.015)
Mother's age (in years)	-0.004*** (0.001)	0.002*** (0.000)	-0.002*** (0.001)	-0.001 (0.001)
Married (dummy)	0.012 (0.023)	-0.100*** (0.012)	0.091*** (0.020)	0.082*** (0.024)
Number of children	0.040*** (0.005)	0.007*** (0.003)	0.080*** (0.005)	-0.017*** (0.005)
Living urban areas (dummy)	-0.052*** (0.007)	-0.010** (0.004)	-0.050*** (0.006)	-0.042*** (0.008)
Medium GNI per capita (dummy)	-0.023** (0.010)	0.014** (0.007)	-0.009 (0.009)	-0.000 (0.013)
High GNI per capita (dummy)	0.037*** (0.010)	-0.012* (0.007)	0.032*** (0.008)	0.021* (0.012)
Constant	0.742*** (0.035)	0.064*** (0.019)	0.979*** (0.042)	1.095*** (0.074)
Observations	34,452	133,506	25,449	21,890
R-squared	0.084	0.073	0.071	0.105

Notes: Time refers to the survey year the data were collected and varies from year 0 (1990) to year 27 (2017). Specific wealth quintiles are calculated for each country and survey year. The PCA approach measures household (HH) wealth, and wealth quintiles are calculated relative to the observed country and survey year. Samples of children vary according to the dependent variable (see Table 3 for age intervals).

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.12: First stage IV estimates (regression of household wealth index on the instrument and covariates)

Dependent outcome:	Household wealth score	
	<i>Linear</i>	<i>Interacted</i>
Area mothers' height	0.423*** (0.017)	0.241*** (0.018)
Medium GNI per capita (dummy)	0.035*** (0.007)	-2.043*** (0.182)
High GNI per capita (dummy)	0.025*** (0.007)	-1.388*** (0.071)
Area mothers' height*MediumGNI/c		1.349*** (0.119)
Area mothers' height*HighGNI/c		0.923*** (0.046)
Child is a male (dummy)	0.003* (0.002)	0.003* (0.002)
Child age (in months)	0.001** (0.001)	0.001* (0.001)
Childbirth size (5-point score)	-0.001 (0.001)	-0.001 (0.001)
Birth order	-0.012*** (0.001)	-0.011*** (0.001)
Birth interval (in months)	-0.000*** (0.000)	-0.000*** (0.000)
Multiple births (dummy)	0.010 (0.010)	0.010 (0.009)
Wanted child (dummy)	0.004 (0.002)	0.002 (0.002)
Number of antenatal visits	0.005*** (0.000)	0.005*** (0.000)
Delivery at home (dummy)	-0.054*** (0.002)	-0.048*** (0.002)
C-section delivery (dummy)	0.021*** (0.003)	0.022*** (0.003)
Primary maternal education (dummy)	0.020*** (0.003)	0.023*** (0.002)
Secondary maternal education (dummy)	0.091*** (0.002)	0.091*** (0.002)
Tertiary maternal education (dummy)	0.177*** (0.005)	0.174*** (0.005)
Mother's age (in years)	0.002*** (0.000)	0.001*** (0.000)
Married (dummy)	0.012 (0.010)	0.005 (0.010)
Number of children	0.007*** (0.002)	0.007*** (0.002)
Living urban areas (dummy)	0.095*** (0.003)	0.092*** (0.003)
Constant	-0.446*** (0.031)	-0.164*** (0.031)
DHS waves	YES	YES
Number of instruments	1	3
Observations	22,788	22,788
R-squared	0.428	0.445
F-stat on excluded instruments	687	440/301/497
Partial R ² on excluded instruments	0.03	0.08/0.15/0.09

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01 ** p<0.05 * p<0.1.

Source: Authors from Asian DHS data (rounds 2 to 7), regression sample of children aged 0 to 5 months when exclusive breastfeeding (EBF) is considered as the dependent variable in the second stage IV estimates.

Table A2.13: IV regressions (using average mothers' height at the PSU level as instruments).

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo (dummy)		Continued breastfeeding at 2 yo (dummy)	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.425*** (0.140)	-1.325** (0.517)	-0.575*** (0.079)	-0.293 (0.268)	-0.367*** (0.131)	-0.203 (0.419)	-1.165*** (0.168)	-2.381*** (0.605)
Medium GNI per capita (dummy)	0.025 (0.021)	-0.097 (0.153)	0.056*** (0.014)	0.199** (0.082)	-0.033 (0.021)	-0.040 (0.125)	-0.072*** (0.026)	-0.341** (0.168)
High GNI per capita (dummy)	0.052*** (0.019)	-0.322** (0.161)	0.078*** (0.012)	0.183** (0.085)	-0.020 (0.019)	0.054 (0.129)	-0.094*** (0.024)	-0.572*** (0.178)
Wealth*MediumGNI/c		0.471 (0.524)		-0.480* (0.283)		0.011 (0.427)		1.003* (0.601)
Wealth*HighGNI/c		1.268** (0.545)		-0.357 (0.288)		-0.248 (0.434)		1.658*** (0.628)
Child is a male (dummy)	-0.003 (0.006)	-0.005 (0.006)	-0.005* (0.003)	-0.005 (0.003)	0.006 (0.006)	0.006 (0.006)	0.038*** (0.007)	0.039*** (0.007)
Child age (in months)	-0.077*** (0.002)	-0.077*** (0.002)	-0.000* (0.000)	-0.000* (0.000)	-0.008*** (0.002)	-0.007*** (0.002)	-0.017*** (0.003)	-0.019*** (0.003)
Childbirth size (5-point score)	-0.001 (0.004)	-0.002 (0.004)	-0.023*** (0.002)	-0.023*** (0.002)	-0.014*** (0.004)	-0.014*** (0.004)	-0.009* (0.005)	-0.009* (0.005)
Birth order	-0.042*** (0.006)	-0.044*** (0.006)	-0.014*** (0.003)	-0.015*** (0.003)	-0.067*** (0.006)	-0.067*** (0.006)	-0.009 (0.006)	-0.010 (0.006)
Birth interval (in months)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Multiple births (dummy)	-0.238*** (0.029)	-0.240*** (0.029)	-0.074*** (0.018)	-0.075*** (0.018)	-0.423*** (0.025)	-0.422*** (0.025)	-0.207*** (0.029)	-0.212*** (0.028)
Wanted child (dummy)	0.011 (0.009)	0.020** (0.009)	0.058*** (0.006)	0.056*** (0.006)	0.037*** (0.010)	0.035*** (0.011)	0.022 (0.013)	0.035** (0.014)
Number of antenatal visits	0.000 (0.001)	0.000 (0.001)	0.009*** (0.001)	0.009*** (0.001)	-0.013*** (0.001)	-0.013*** (0.001)	-0.029*** (0.001)	-0.028*** (0.001)
Delivery at home (dummy)	0.003 (0.011)	-0.007 (0.012)	-0.031*** (0.007)	-0.033*** (0.007)	-0.018* (0.010)	-0.014 (0.010)	-0.086*** (0.013)	-0.097*** (0.014)
C-section delivery (dummy)	0.016 (0.011)	-0.006 (0.013)	-0.173*** (0.006)	-0.168*** (0.007)	0.037*** (0.011)	0.042*** (0.013)	0.068*** (0.015)	0.033** (0.016)
Primary maternal education (dummy)	-0.014 (0.010)	-0.012 (0.010)	0.078*** (0.006)	0.077*** (0.006)	0.030*** (0.009)	0.031*** (0.009)	0.027** (0.012)	0.028** (0.012)
Secondary maternal education (dummy)	0.022 (0.016)	0.014 (0.014)	0.156*** (0.009)	0.158*** (0.009)	0.039*** (0.015)	0.041*** (0.013)	0.084*** (0.020)	0.073*** (0.017)
Tertiary maternal education (dummy)	0.063** (0.030)	0.027 (0.025)	0.168*** (0.017)	0.179*** (0.015)	0.051* (0.029)	0.059** (0.023)	0.150*** (0.038)	0.111*** (0.030)
Mother's age (in years)	-0.002** (0.001)	-0.002** (0.001)	0.004*** (0.001)	0.004*** (0.001)	-0.002* (0.001)	-0.002** (0.001)	0.002 (0.001)	0.002 (0.001)
Married (dummy)	0.035 (0.032)	0.034 (0.032)	-0.081*** (0.016)	-0.077*** (0.016)	0.100*** (0.030)	0.102*** (0.030)	0.110*** (0.032)	0.095*** (0.031)
Number of children	0.048*** (0.006)	0.052*** (0.006)	0.010*** (0.003)	0.010*** (0.003)	0.082*** (0.006)	0.080*** (0.006)	0.002 (0.007)	0.008 (0.007)
Living urban areas (dummy)	-0.004 (0.016)	-0.014 (0.013)	0.029*** (0.009)	0.035*** (0.008)	-0.024* (0.014)	-0.023** (0.011)	0.067*** (0.019)	0.049*** (0.015)
Constant	0.575*** (0.061)	0.832*** (0.156)	0.200*** (0.032)	0.112 (0.080)	0.956*** (0.065)	0.908*** (0.131)	1.297*** (0.105)	1.672*** (0.199)
DHS waves	YES	YES	YES	YES	YES	YES	YES	YES
Number of instruments	1	3	1	3	1	3	1	3
Instruments	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c	Area mothers' height	Area mothers' height and its interactions with medium GNI/c and high GNI/c
Observations	22,788	22,788	92,849	92,849	16,817	16,817	15,153	15,153

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01. ** p<0.05. * p<0.1. Samples of children vary according to the dependent variable (see Table 4).

Source: Authors from Asian DHS data (rounds 2 to 7).

Table A2.14: OLS regressions of BF practices on household wealth (calculated with an MCA approach), GNI/capita and covariates.

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo (dummy)		Continued breastfeeding at 2 yo (dummy)	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.153*** (0.016)	-0.387*** (0.028)	-0.092*** (0.010)	-0.161*** (0.017)	-0.124*** (0.014)	-0.169*** (0.026)	-0.160*** (0.018)	-0.227*** (0.034)
Medium GNI per capita (dummy)	-0.014 (0.011)	-0.089*** (0.020)	0.023*** (0.008)	0.028** (0.013)	-0.016 (0.010)	-0.020 (0.016)	-0.029** (0.014)	-0.008 (0.023)
High GNI per capita (dummy)	0.042*** (0.010)	-0.081*** (0.016)	0.066*** (0.007)	0.027** (0.011)	0.001 (0.009)	-0.024* (0.013)	-0.035*** (0.013)	-0.075*** (0.019)
Wealth*MediumGNI		0.197*** (0.043)		-0.016 (0.026)		0.009 (0.040)		-0.057 (0.051)
Wealth*HighGNI		0.322*** (0.030)		0.107*** (0.019)		0.067** (0.027)		0.108*** (0.035)
Child is a male (dummy)	-0.015*** (0.005)	-0.015*** (0.005)	-0.005* (0.003)	-0.005* (0.003)	-0.002 (0.005)	-0.002 (0.005)	0.027*** (0.006)	0.027*** (0.006)
Child age (in months)	-0.080*** (0.002)	-0.081*** (0.002)	0.000 (0.000)	0.000 (0.000)	-0.004* (0.002)	-0.004* (0.002)	-0.021*** (0.003)	-0.021*** (0.003)
Childbirth size (5-point score)	-0.009*** (0.003)	-0.010*** (0.003)	-0.017*** (0.002)	-0.018*** (0.002)	-0.017*** (0.003)	-0.017*** (0.003)	-0.011*** (0.004)	-0.011*** (0.004)
Birth order	-0.034*** (0.004)	-0.036*** (0.004)	-0.005** (0.002)	-0.006** (0.002)	-0.070*** (0.004)	-0.070*** (0.004)	0.005 (0.005)	0.004 (0.005)
Birth interval (in months)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Multiple births (dummy)	-0.219*** (0.024)	-0.219*** (0.024)	-0.052*** (0.014)	-0.052*** (0.014)	-0.406*** (0.021)	-0.407*** (0.021)	-0.197*** (0.023)	-0.198*** (0.023)
Wanted child (dummy)	-0.000 (0.007)	0.000 (0.007)	0.043*** (0.004)	0.044*** (0.004)	0.018** (0.008)	0.018** (0.008)	0.003 (0.010)	0.004 (0.010)
Number of antenatal visits	-0.001 (0.001)	-0.000 (0.001)	0.004*** (0.000)	0.004*** (0.000)	-0.012*** (0.001)	-0.012*** (0.001)	-0.026*** (0.001)	-0.026*** (0.001)
Delivery at home (dummy)	0.025*** (0.007)	0.018*** (0.007)	-0.007* (0.004)	-0.011*** (0.004)	-0.008 (0.006)	-0.010* (0.006)	-0.026*** (0.008)	-0.031*** (0.008)
C-section delivery (dummy)	0.003 (0.010)	-0.007 (0.010)	-0.183*** (0.005)	-0.187*** (0.005)	0.012 (0.009)	0.009 (0.009)	0.028** (0.012)	0.024** (0.012)
Primary maternal education (dummy)	-0.013* (0.008)	-0.012 (0.008)	0.048*** (0.004)	0.048*** (0.004)	0.034*** (0.006)	0.034*** (0.007)	0.009 (0.009)	0.009 (0.009)
Secondary maternal education (dummy)	-0.003 (0.008)	-0.003 (0.008)	0.093*** (0.004)	0.092*** (0.004)	0.022*** (0.007)	0.021*** (0.007)	-0.007 (0.009)	-0.008 (0.009)
Tertiary maternal education (dummy)	0.013 (0.013)	0.004 (0.013)	0.081*** (0.007)	0.078*** (0.007)	-0.008 (0.013)	-0.010 (0.013)	-0.053*** (0.015)	-0.056*** (0.015)
Mother's age (in years)	-0.003*** (0.001)	-0.003*** (0.001)	0.001*** (0.000)	0.001*** (0.000)	-0.002*** (0.001)	-0.002*** (0.001)	0.001 (0.001)	0.001 (0.001)
Married (dummy)	0.027 (0.023)	0.019 (0.023)	-0.063*** (0.011)	-0.066*** (0.011)	0.077*** (0.020)	0.075*** (0.020)	0.057** (0.024)	0.054** (0.024)
Number of children	0.041*** (0.005)	0.043*** (0.005)	0.006** (0.002)	0.007*** (0.002)	0.083*** (0.005)	0.084*** (0.005)	-0.011** (0.005)	-0.010* (0.005)
Living urban areas (dummy)	-0.030*** (0.007)	-0.027*** (0.007)	-0.007 (0.005)	-0.006 (0.005)	-0.026*** (0.006)	-0.026*** (0.006)	-0.005 (0.008)	-0.005 (0.008)
DHSwave3	0.006 (0.017)	-0.012 (0.017)	-0.005 (0.014)	-0.009 (0.014)	0.053*** (0.014)	0.050*** (0.014)	0.067*** (0.021)	0.063*** (0.021)
DHSwave4	0.030* (0.018)	0.023 (0.018)	0.247*** (0.015)	0.245*** (0.015)	0.052*** (0.015)	0.050*** (0.015)	0.094*** (0.024)	0.091*** (0.024)
DHSwave5	0.003 (0.017)	0.018 (0.017)	0.323*** (0.013)	0.328*** (0.013)	-0.011 (0.015)	-0.007 (0.015)	-0.008 (0.022)	-0.003 (0.022)
DHSwave6	0.070*** (0.016)	0.080*** (0.016)	0.277*** (0.011)	0.278*** (0.011)	0.030** (0.014)	0.031** (0.014)	0.140*** (0.022)	0.140*** (0.022)
DHSwave7	0.107*** (0.016)	0.107*** (0.016)	0.397*** (0.012)	0.396*** (0.012)	-0.042*** (0.014)	-0.042*** (0.014)	0.016 (0.022)	0.015 (0.022)
Constant	0.743*** (0.034)	0.830*** (0.036)	0.134*** (0.021)	0.161*** (0.022)	0.919*** (0.041)	0.936*** (0.042)	1.094*** (0.074)	1.122*** (0.074)
Observations	34,452	34,452	133,506	133,506	25,449	25,449	21,890	21,890
R-squared	0.087	0.090	0.084	0.084	0.081	0.081	0.119	0.120

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01 ** p<0.05 * p<0.1.

Source: Authors from Asian DHS data (rounds 2 to 7). Samples of children vary according to the dependent variable (see Table 3 for age intervals).

Table A2.15: OLS regressions of BF practices on household wealth (calculated with a PCA approach), GDP/capita and covariates.

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo (dummy)		Continued breastfeeding at 2 yo (dummy)	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.149*** (0.019)	-0.491*** (0.039)	-0.107*** (0.011)	-0.165*** (0.024)	-0.131*** (0.017)	-0.221*** (0.034)	-0.159*** (0.023)	-0.417*** (0.045)
Medium GDP per capita (dummy)	-0.019** (0.009)	-0.151*** (0.015)	-0.106*** (0.006)	-0.127*** (0.009)	0.003 (0.007)	-0.039*** (0.012)	0.005 (0.011)	-0.083*** (0.017)
High GDP per capita (dummy)	-0.062*** (0.011)	-0.140*** (0.020)	-0.104*** (0.007)	-0.121*** (0.012)	-0.032*** (0.010)	-0.022 (0.017)	-0.003 (0.013)	-0.086*** (0.023)
Wealth*MediumGDP		0.472*** (0.043)		0.076*** (0.026)		0.146*** (0.038)		0.320*** (0.049)
Wealth*HighGDP		0.326*** (0.050)		0.066** (0.029)		0.006 (0.047)		0.306*** (0.059)
Child is a male (dummy)	-0.015*** (0.005)	-0.015*** (0.005)	-0.005* (0.003)	-0.005* (0.003)	-0.002 (0.005)	-0.003 (0.005)	0.027*** (0.006)	0.027*** (0.006)
Child age (in months)	-0.080*** (0.002)	-0.080*** (0.002)	0.000 (0.000)	0.000 (0.000)	-0.004* (0.002)	-0.004* (0.002)	-0.021*** (0.003)	-0.021*** (0.003)
Childbirth size (5-point score)	-0.012*** (0.003)	-0.013*** (0.003)	-0.020*** (0.002)	-0.020*** (0.002)	-0.018*** (0.003)	-0.018*** (0.003)	-0.011*** (0.004)	-0.011*** (0.004)
Birth order	-0.036*** (0.004)	-0.037*** (0.004)	-0.007*** (0.002)	-0.008*** (0.002)	-0.070*** (0.004)	-0.070*** (0.004)	0.005 (0.005)	0.004 (0.005)
Birth interval (in months)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Multiple births (dummy)	-0.215*** (0.024)	-0.216*** (0.024)	-0.057*** (0.014)	-0.057*** (0.014)	-0.408*** (0.021)	-0.407*** (0.021)	-0.195*** (0.023)	-0.194*** (0.023)
Wanted child (dummy)	0.000 (0.007)	0.000 (0.007)	0.042*** (0.004)	0.042*** (0.004)	0.019** (0.008)	0.019** (0.008)	0.002 (0.010)	0.005 (0.010)
Number of antenatal visits	-0.000 (0.001)	-0.000 (0.001)	0.006*** (0.000)	0.006*** (0.000)	-0.011*** (0.001)	-0.011*** (0.001)	-0.027*** (0.001)	-0.027*** (0.001)
Delivery at home (dummy)	0.024*** (0.007)	0.019*** (0.007)	-0.015*** (0.004)	-0.016*** (0.004)	-0.006 (0.006)	-0.008 (0.006)	-0.023*** (0.008)	-0.026*** (0.008)
C-section delivery (dummy)	-0.003 (0.010)	-0.011 (0.010)	-0.184*** (0.005)	-0.185*** (0.005)	0.008 (0.009)	0.004 (0.009)	0.024** (0.012)	0.018 (0.012)
Primary maternal education (dummy)	-0.004 (0.008)	-0.003 (0.008)	0.069*** (0.004)	0.069*** (0.004)	0.035*** (0.007)	0.033*** (0.007)	0.002 (0.009)	0.005 (0.009)
Secondary maternal education (dummy)	0.001 (0.008)	-0.002 (0.008)	0.104*** (0.004)	0.104*** (0.004)	0.020*** (0.007)	0.018*** (0.007)	-0.017* (0.009)	-0.016* (0.009)
Tertiary maternal education (dummy)	0.013 (0.013)	0.001 (0.013)	0.090*** (0.007)	0.088*** (0.007)	-0.010 (0.013)	-0.013 (0.013)	-0.065*** (0.015)	-0.070*** (0.015)
Mother's age (in years)	-0.002*** (0.001)	-0.003*** (0.001)	0.003*** (0.000)	0.003*** (0.000)	-0.002** (0.001)	-0.002** (0.001)	0.001 (0.001)	0.000 (0.001)
Married (dummy)	0.012 (0.023)	0.019 (0.023)	-0.089*** (0.011)	-0.089*** (0.011)	0.078*** (0.020)	0.079*** (0.020)	0.061** (0.024)	0.059** (0.024)
Number of children	0.040*** (0.005)	0.042*** (0.005)	0.004* (0.002)	0.005** (0.002)	0.082*** (0.005)	0.083*** (0.005)	-0.011** (0.005)	-0.009* (0.005)
Living urban areas (dummy)	-0.041*** (0.007)	-0.044*** (0.007)	-0.013*** (0.004)	-0.014*** (0.004)	-0.033*** (0.006)	-0.033*** (0.006)	-0.014* (0.008)	-0.015* (0.008)
DHSwave3	0.026 (0.017)	0.005 (0.017)	0.020* (0.011)	0.017 (0.011)	0.070*** (0.014)	0.062*** (0.014)	0.080*** (0.022)	0.068*** (0.022)
DHSwave4	0.063*** (0.019)	0.034* (0.019)	0.281*** (0.014)	0.277*** (0.014)	0.078*** (0.016)	0.065*** (0.016)	0.107*** (0.025)	0.087*** (0.025)
DHSwave5	0.036** (0.017)	0.015 (0.017)	0.370*** (0.012)	0.367*** (0.012)	0.009 (0.015)	0.003 (0.015)	-0.005 (0.023)	-0.020 (0.023)
DHSwave6	0.122*** (0.015)	0.114*** (0.015)	0.395*** (0.011)	0.393*** (0.011)	0.040*** (0.012)	0.037*** (0.012)	0.121*** (0.020)	0.115*** (0.020)
DHSwave7	0.145*** (0.015)	0.153*** (0.015)	0.454*** (0.011)	0.455*** (0.011)	-0.024* (0.014)	-0.022 (0.014)	0.007 (0.021)	0.010 (0.021)
Constant	0.740*** (0.035)	0.846*** (0.037)	0.172*** (0.019)	0.190*** (0.021)	0.902*** (0.042)	0.929*** (0.042)	1.081*** (0.074)	1.165*** (0.075)
Observations	34,452	34,452	133,506	133,506	25,449	25,449	21,890	21,890
R-squared	0.086	0.090	0.087	0.087	0.081	0.082	0.117	0.119

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01 ** p<0.05 * p<0.1.

Source: Authors from Asian DHS data (rounds 2 to 7), regression sample of children aged 0 to 5 months.

Table A2.16: OLS regressions of BF practices on household wealth (calculated with a PCA approach), HDI and covariates.

Dependent outcome:	Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo (dummy)		Continued breastfeeding at 2 yo (dummy)	
	Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score	-0.158*** (0.019)	-0.394*** (0.041)	-0.113*** (0.011)	-0.198*** (0.027)	-0.134*** (0.017)	-0.201*** (0.035)	-0.149*** (0.023)	-0.284*** (0.050)
Medium HDI (dummy)	-0.049*** (0.012)	-0.130*** (0.017)	0.015* (0.008)	-0.013 (0.011)	-0.019** (0.009)	-0.045*** (0.013)	-0.091*** (0.013)	-0.128*** (0.018)
High HDI (dummy)	-0.100*** (0.014)	-0.228*** (0.029)	0.033*** (0.009)	-0.010 (0.018)	-0.077*** (0.014)	-0.031 (0.029)	-0.174*** (0.017)	-0.287*** (0.037)
Wealth*MediumHDI		0.290*** (0.045)		0.101*** (0.029)		0.105*** (0.038)		0.142*** (0.053)
Wealth*HighHDI		0.371*** (0.065)		0.127*** (0.039)		-0.073 (0.064)		0.305*** (0.082)
Child is a male (dummy)	-0.015*** (0.005)	-0.014*** (0.005)	-0.005* (0.003)	-0.005* (0.003)	-0.002 (0.005)	-0.002 (0.005)	0.028*** (0.006)	0.028*** (0.006)
Child age (in months)	-0.080*** (0.002)	-0.080*** (0.002)	0.000 (0.000)	0.000 (0.000)	-0.004* (0.002)	-0.004* (0.002)	-0.021*** (0.003)	-0.021*** (0.003)
Childbirth size (5-point score)	-0.012*** (0.003)	-0.013*** (0.003)	-0.018*** (0.002)	-0.018*** (0.002)	-0.018*** (0.003)	-0.018*** (0.003)	-0.013*** (0.004)	-0.013*** (0.004)
Birth order	-0.035*** (0.004)	-0.036*** (0.004)	-0.005** (0.002)	-0.005** (0.002)	-0.070*** (0.004)	-0.070*** (0.004)	0.004 (0.005)	0.003 (0.005)
Birth interval (in months)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Multiple births (dummy)	-0.216*** (0.024)	-0.217*** (0.024)	-0.050*** (0.014)	-0.050*** (0.014)	-0.406*** (0.021)	-0.407*** (0.020)	-0.197*** (0.023)	-0.197*** (0.023)
Wanted child (dummy)	-0.000 (0.007)	-0.001 (0.007)	0.044*** (0.004)	0.045*** (0.004)	0.017** (0.008)	0.017** (0.008)	0.001 (0.010)	0.002 (0.010)
Number of antenatal visits	0.000 (0.001)	0.000 (0.001)	0.004*** (0.000)	0.004*** (0.000)	-0.011*** (0.001)	-0.011*** (0.001)	-0.026*** (0.001)	-0.026*** (0.001)
Delivery at home (dummy)	0.022*** (0.007)	0.022*** (0.007)	-0.012*** (0.004)	-0.012*** (0.004)	-0.008 (0.006)	-0.008 (0.006)	-0.024*** (0.008)	-0.024*** (0.008)
C-section delivery (dummy)	-0.004 (0.010)	-0.008 (0.010)	-0.182*** (0.005)	-0.184*** (0.005)	0.006 (0.009)	0.004 (0.009)	0.016 (0.012)	0.015 (0.012)
Primary maternal education (dummy)	0.001 (0.008)	0.004 (0.008)	0.045*** (0.004)	0.046*** (0.004)	0.039*** (0.007)	0.038*** (0.007)	0.028*** (0.009)	0.031*** (0.009)
Secondary maternal education (dummy)	0.010 (0.008)	0.008 (0.008)	0.090*** (0.004)	0.089*** (0.004)	0.027*** (0.007)	0.024*** (0.007)	0.010 (0.009)	0.011 (0.009)
Tertiary maternal education (dummy)	0.023* (0.013)	0.013 (0.013)	0.078*** (0.007)	0.075*** (0.007)	-0.002 (0.013)	-0.006 (0.013)	-0.040*** (0.015)	-0.045*** (0.015)
Mother's age (in years)	-0.002*** (0.001)	-0.002*** (0.001)	0.001*** (0.000)	0.001*** (0.000)	-0.001** (0.001)	-0.001** (0.001)	0.002** (0.001)	0.002** (0.001)
Married (dummy)	0.005 (0.023)	0.007 (0.023)	-0.074*** (0.012)	-0.074*** (0.012)	0.075*** (0.020)	0.077*** (0.020)	0.052** (0.024)	0.050** (0.024)
Number of children	0.040*** (0.005)	0.041*** (0.005)	0.006** (0.002)	0.007*** (0.002)	0.082*** (0.005)	0.082*** (0.005)	-0.014** (0.005)	-0.013** (0.005)
Living urban areas (dummy)	-0.041*** (0.007)	-0.042*** (0.007)	-0.013*** (0.004)	-0.013*** (0.004)	-0.033*** (0.006)	-0.033*** (0.006)	-0.014* (0.008)	-0.014* (0.008)
DHSwave3	0.046** (0.019)	0.038** (0.019)	-0.039*** (0.012)	-0.045*** (0.012)	0.072*** (0.015)	0.070*** (0.015)	0.144*** (0.022)	0.138*** (0.023)
DHSwave4	0.071*** (0.020)	0.062*** (0.020)	0.217*** (0.014)	0.210*** (0.014)	0.071*** (0.016)	0.067*** (0.016)	0.164*** (0.024)	0.156*** (0.025)
DHSwave5	0.052*** (0.018)	0.058*** (0.018)	0.311*** (0.012)	0.310*** (0.012)	0.009 (0.016)	0.008 (0.016)	0.055** (0.024)	0.055** (0.024)
DHSwave6	0.164*** (0.018)	0.168*** (0.018)	0.296*** (0.012)	0.295*** (0.012)	0.059*** (0.015)	0.057*** (0.015)	0.216*** (0.024)	0.215*** (0.024)
DHSwave7	0.180*** (0.017)	0.192*** (0.017)	0.397*** (0.012)	0.399*** (0.012)	-0.007 (0.015)	-0.004 (0.015)	0.094*** (0.023)	0.096*** (0.023)
Constant	0.733*** (0.035)	0.796*** (0.036)	0.178*** (0.019)	0.203*** (0.021)	0.903*** (0.041)	0.920*** (0.042)	1.045*** (0.074)	1.082*** (0.075)
Observations	34,452	34,452	133,506	133,506	25,449	25,449	21,890	21,890
R-squared	0.086	0.088	0.082	0.082	0.082	0.083	0.122	0.123

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis. *** p<0.01 ** p<0.05 * p<0.1.

Source: Authors from Asian DHS data (rounds 2 to 7), regression sample of children aged 0 to 5 months.

Table A2.17: Alternative regressions including (less well-answered) additional covariates about mothers' characteristics (working status, BMI, and religious affiliation).

Dependent outcome:			Exclusive breastfeeding (dummy)		Early initiation (dummy)		Continued breastfeeding at 1 yo		Continued breastfeeding at 2 yo	
			Linear	Interacted	Linear	Interacted	Linear	Interacted	Linear	Interacted
Household wealth score			-0.147*** (0.046)	-0.595*** (0.073)	-0.090*** (0.024)	-0.126** (0.050)	-0.100** (0.042)	-0.222*** (0.085)	-0.024 (0.049)	-0.243*** (0.089)
Medium GNI per capita (dummy)			0.173*** (0.039)	0.036 (0.048)	0.162*** (0.023)	0.163*** (0.028)	-0.057 (0.036)	-0.099** (0.040)	-0.112*** (0.043)	-0.208*** (0.046)
High GNI per capita (dummy)			-0.001 (0.035)	-0.121*** (0.042)	0.069*** (0.021)	0.056** (0.025)	-0.092*** (0.034)	-0.125*** (0.038)	-0.269*** (0.040)	-0.319*** (0.044)
Wealth*MediumGNI				0.670*** (0.127)		-0.008 (0.074)		0.201* (0.114)		0.477*** (0.123)
Wealth*HighGNI				0.535*** (0.083)		0.052 (0.054)		0.144 (0.091)		0.239** (0.098)
Child is a male (dummy)			-0.008 (0.012)	-0.007 (0.012)	-0.008 (0.006)	-0.008 (0.006)	-0.011 (0.010)	-0.011 (0.010)	0.012 (0.012)	0.013 (0.012)
Child age (in months)			-0.084*** (0.004)	-0.083*** (0.004)	0.000 (0.000)	0.000 (0.000)	0.002 (0.004)	0.002 (0.004)	-0.011** (0.005)	-0.012** (0.005)
Childbirth size (5-point score)			-0.001 (0.007)	-0.001 (0.007)	-0.013*** (0.004)	-0.013*** (0.004)	-0.009 (0.006)	-0.009 (0.006)	-0.005 (0.008)	-0.005 (0.008)
Birth order			-0.010 (0.009)	-0.011 (0.009)	-0.000 (0.004)	-0.000 (0.004)	-0.056*** (0.009)	-0.056*** (0.009)	-0.003 (0.009)	-0.005 (0.009)
Birth interval (in months)			0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.001** (0.000)	0.001** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Multiple births (dummy)			-0.333*** (0.054)	-0.337*** (0.054)	-0.024 (0.030)	-0.024 (0.030)	-0.287*** (0.052)	-0.290*** (0.051)	-0.133*** (0.047)	-0.136*** (0.048)
Wanted child (dummy)			0.016 (0.014)	0.016 (0.014)	0.039*** (0.009)	0.040*** (0.009)	0.012 (0.014)	0.013 (0.014)	0.029 (0.018)	0.027 (0.018)
Number of antenatal visits			-0.003 (0.002)	-0.002 (0.002)	0.005*** (0.001)	0.005*** (0.001)	-0.009*** (0.002)	-0.009*** (0.002)	-0.027*** (0.002)	-0.027*** (0.002)
Delivery at home (dummy)			0.051*** (0.015)	0.040** (0.016)	-0.011 (0.008)	-0.012 (0.008)	0.020 (0.013)	0.017 (0.013)	0.010 (0.017)	0.004 (0.017)
C-section delivery (dummy)			0.097*** (0.024)	0.079*** (0.024)	-0.168*** (0.012)	-0.168*** (0.012)	0.059*** (0.020)	0.052*** (0.020)	0.057** (0.027)	0.041 (0.027)
Mother is working (dummy)			-0.005 (0.015)	-0.010 (0.015)	0.013* (0.008)	0.013* (0.008)	0.026** (0.012)	0.024** (0.012)	0.026* (0.015)	0.025* (0.015)
Mother's BMI (kg/m ²)			-0.002 (0.002)	-0.002 (0.002)	-0.001 (0.001)	-0.001 (0.001)	-0.008*** (0.002)	-0.008*** (0.002)	-0.015*** (0.002)	-0.015*** (0.002)
Christian (dummy)			0.163*** (0.033)	0.156*** (0.033)	0.269*** (0.019)	0.269*** (0.019)	0.024 (0.027)	0.022 (0.027)	-0.051 (0.037)	-0.055 (0.036)
Hindu (dummy)			0.168*** (0.019)	0.156*** (0.019)	0.027*** (0.010)	0.027*** (0.010)	0.048*** (0.014)	0.044*** (0.014)	0.078*** (0.018)	0.071*** (0.018)
Bouddhist (dummy)			0.245*** (0.054)	0.225*** (0.054)	0.034 (0.027)	0.033 (0.027)	0.057** (0.026)	0.053** (0.026)	0.113*** (0.038)	0.102*** (0.038)
Others (dummy)			0.120** (0.051)	0.103** (0.051)	0.066** (0.029)	0.064** (0.029)	0.029 (0.039)	0.025 (0.039)	0.134** (0.053)	0.125** (0.053)
Primary	maternal	education	-0.055*** (0.018)	-0.053*** (0.018)	0.026*** (0.009)	0.026*** (0.009)	0.022* (0.013)	0.023* (0.013)	0.006 (0.018)	0.009 (0.018)
Secondary	maternal	education	-0.047*** (0.017)	-0.043** (0.017)	0.044*** (0.009)	0.045*** (0.009)	0.002 (0.014)	0.004 (0.014)	0.010 (0.017)	0.013 (0.017)
Tertiary	maternal	education	-0.002 (0.031)	-0.002 (0.031)	0.019 (0.015)	0.019 (0.015)	0.023 (0.026)	0.022 (0.027)	-0.040 (0.035)	-0.037 (0.034)
Mother's age (in years)			-0.004** (0.002)	-0.004** (0.002)	0.001 (0.001)	0.001 (0.001)	-0.003** (0.001)	-0.003** (0.001)	0.002 (0.002)	0.003 (0.002)
Married (dummy)			-0.005 (0.045)	-0.005 (0.045)	0.027 (0.021)	0.027 (0.021)	0.092** (0.046)	0.091** (0.046)	0.059 (0.046)	0.058 (0.046)
Number of children			0.022** (0.010)	0.023** (0.010)	-0.003 (0.005)	-0.003 (0.005)	0.080*** (0.010)	0.080*** (0.010)	0.011 (0.010)	0.012 (0.010)
Living urban areas (dummy)			-0.015 (0.016)	-0.014 (0.016)	0.016* (0.009)	0.016* (0.009)	-0.048*** (0.015)	-0.048*** (0.015)	-0.003 (0.016)	-0.002 (0.016)
Constant			0.760*** (0.082)	0.850*** (0.084)	0.226*** (0.040)	0.425*** (0.042)	0.933*** (0.093)	0.863*** (0.097)	1.148*** (0.138)	1.283*** (0.143)
DHS rounds			YES	YES	YES	YES	YES	YES	YES	YES
Observations			6,776	6,776	27,782	27,782	5,029	5,029	4,630	4,630
R-squared			0.120	0.125	0.150	0.150	0.124	0.125	0.248	0.250

Notes: Standard errors are clustered at the PSU level. Robust standard errors are in parenthesis: *** p<0.01 ** p<0.05 * p<0.1. Samples of children vary according to the dependent variable (see Table 3 for age intervals).

Source: Authors from Asian DHS data (rounds 2 to 7).

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Chapter 3: Gender role attitudes transformation: a sociocultural mechanism of the obesity epidemic.

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Abstract:

Worldwide, obesity is gaining ground, a risk to which women are more heavily exposed than men in traditional societies. In this article, we examine how the transformation of gender role attitudes affects this obesity gender gap and the prevalence of obesity for both sexes. To do this, we use a panel database from 168 countries over 27 years (1990-2016). Two measures of gender attitudes (GA) are used: a) the Women, Business, and the Law (WBL) index of the World Bank; b) a multidimensional index based on a Principal Component Analysis and combining three dimensions (the WBL index, fertility rates, and women's labor force participation). Econometrically, we run time-individual fixed effects. To the extent possible, we also attempt to control for endogeneity bias through an instrumental variable strategy. Our results reveal that the gender-obesity relationship is non-linear and different according to sex, with a U-shape for men and a U-inverted for women. Modern GA initially contribute to the increase in the female burden of obesity. However, the gender gap in obesity tends to narrow in the long term as more gender-egalitarian attitudes are adopted. Overall, it seems that the rise in men's obesity prevalence is greater than women's obesity prevalence decline. Consequently, a reduction in the obesity gender gap does not necessarily mean improvements in the fight against obesity. Our research ultimately concludes that changes in gender role attitudes play an important role in explaining the history of the nutritional transition. We recommend that cultural and societal factors, especially those related to gender, be given more weight to understand better how malnutrition-related behaviors evolve.

Keywords: Obesity; gender role attitudes; globalization; nutrition transition; gender inequality.

JEL: I12; I14; I15; I18, J1.

1. Introduction

Obesity, defined as a body-mass index (BMI) equal to or greater than 30.0, has significant adverse effects on the health of populations. It is associated with various health conditions, including type-2 diabetes, cardiovascular diseases, hypertension, stroke and many cancers (Swinburn et al., 2011). Unfortunately, most of the world's population now resides in countries where overweight and obesity are responsible for more deaths than underweight. As such, the World Health Organization (WHO)²⁴ reports that obesity has tripled since 1975, and it has become a global issue, affecting not only high-income countries but all countries. In 2017 alone, obesity was one of the leading early death risk factors, contributing to 4.72 million deaths and 148 million disability-adjusted life years (Stanaway et al., 2018). However, despite these alarming statistics, there is still much to learn about the determinants of this "severe obesity epidemic" (NCD Risk Factor Collaboration, 2016). Further research is needed to understand the determinants contributing to the rise of obesity worldwide.

In the literature, the rise of obesity is mainly explained by its socio-economic drivers. Rapid economic growth, development, and urbanization have increased food availability at lower prices, changing people's diets and lifestyle habits (Shetty & Schmidhuber, 2006). Nevertheless, this process of nutritional transition, described by Popkin (2011), is underway at varying rates depending on the combined effects of enriching countries and individuals. To briefly describe the state of knowledge on this issue, existing research has consistently demonstrated a clear link between socio-economic status (SES) and obesity. In low-middle-income countries (LMICs), obesity is associated with higher SES, while in high-income countries (HICs), it is associated with lower SES (Neuman et al., 2011; Pampel et al., 2012). We also know that this SES-obesity gradient varies according to individuals' sex. In low-income countries (LICs), research has demonstrated a positive relationship between SES and obesity both for men and women. As countries move into middle-income status (MICs), the association gradually shifts to a mixed one for men and a negative one for women (Dinsa et al., 2012). Finally, in HICs, this relationship is negative among women and inconsistent for men (Sobal & Stunkard, 1989; McLaren, 2007).

²⁴ <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> (accessed on: 13/10/2023).

Although underexplored in the previously mentioned literature, food consumption is also influenced by various religious, societal, and cultural factors (Atkin et al., 2021). Alonso (2015) mentions, in this regard, that food choices reflect the feeling of belonging to a particular group, determined by what one eats and how. Food is, therefore, intrinsically linked to the concept of culture that can be defined, for clarification purposes, as "the collective programming of the mind which distinguishes the members of one group or society from another" (Hofstede, 1991, p. 5). By extension, food also seems to be linked to the concept of gender, which "refers to the socially constructed roles, behaviors, activities and attributes that a given society considers appropriate for men and women."²⁵ Unfortunately, culture and its associated dimensions remain one of the least explored factors of obesity due to challenges in their conceptualization and quantification, particularly at the macroeconomic level. Here, we are particularly interested in the notion of gender because the literature informs us that gender roles determine the norms of behavior of men and women regarding family, work or education, thus affecting people's health (Tannenbaum et al., 2016). In developing countries, for instance, traditional attitudes toward gender roles often lead to low participation of women in labor market activities, higher fertility rates and reduced daily physical activity, all of which increase their biological risk of obesity (Kanter & Caballero, 2012). In these countries, Costa-Font & Györi (2020) evocate that obesity appears as the "weight of patriarchy," with an obesity gender gap deeply rooted in the traditional culture and gender norms (Jayachandran, 2015). Conversely, in developed countries, modernity has changed gender role attitudes, and women progressively shift from caring for their families to career development. In another manner, this new lifestyle may either increase their likelihood of obesity, as it reduces their ability to consume healthy and homemade foods in favor of high-fat and high-energy foods (Yoon et al., 2016) or decrease the previous "weight of patriarchy."

In this article, we propose to advance on this path by questioning the intriguing relationship between the emergence of obesity in the 1970s and the decline in religiosity, namely, the secularization movement of societies. During the twentieth century, this secularization was accompanied by a sacralization movement (Goldstein, 2009), and religions responded differently to secular societies depending on the country (Wilson, 2016). However, whatever these religious shifts are, they are essential as they affect attitudes toward gender roles and

²⁵ Definition extract from the Gender Equality Glossary (2016): Article 3C of the Istanbul Convention of Council of Europe. Available at : [Gender Equality Glossary \(coe.int\)](https://www.coe.int/t/e/gender_equality_glossary/eng/glossary.asp) (accessed on: 13/10/2023).

various gender inequality outcomes, such as female-to-male education enrollment rates or labor force participation, according to Seguino (2011). From our perspective, it is therefore reasonable to assume that these changes in gender role attitudes (GA) may also influence gender inequalities in health, in particular the risk of obesity, which is of interest to us here. To support this statement, a study in China has already demonstrated that GA contribute to an obesity gender gap, with a higher obesity risk observed among women than men (He & Xie, 2022). However, this obesity risk and obesity gender gap evolve with the economic and social development of countries. Nowadays, overweight and obesity are more common among women in LMICs, whereas the prevalence mainly concerns men in HICs (Masood, 2015). Consequently, we propose extending research on obesity-gender relationships by further investigations based on cross-country and time comparisons would be interesting. Another avenue for research would be exploring the impact of GA on countries' absolute levels of obesity as a potential factor of rising obesity. With this article, we aim to contribute to the existing literature by addressing these gaps in research. Based on the previous observations, we hypothesize that the transformation of attitudes related to gender roles would be an essential part of the nutrition transition story. More specifically, we propose that GA explain one part of the reversal of the SES-obesity gradient for women and account for the shift in obesity risk from women to men.

Using a rich panel database of 4536 observations covering 168 countries over the 1990- 2016 period, we analyze how the transformation in GA influences the prevalence of obesity for both sexes and the evolution of the obesity gender gap. Our database was created by combining two sets of data. The first one is data from the WHO Global Health Observatory that gives the prevalence of obesity by population. The second one is data from the World Bank, which provides measurements of GA and other macroeconomic determinants of obesity. This paper's main challenge is measuring societies' cultural transition regarding GA. To address this, we first used, as a proxy, the Women, Business, and the Law (WBL) index of the World Bank, which measures changes towards more gender-equal laws. Then, we complemented our analysis with a more comprehensive indicator of GA, created using a Principal Component Analysis (PCA). This composite indicator combines three dimensions: the evolution of the WBL index, the total fertility rate, and women's labor force participation. Finally, we used econometric methods, including time-individual fixed effects (FE) and instrumental variable (IV) regressions, to address potential endogeneity issues and ensure the robustness of our findings.

First, our results emphasize a positive association between shifts in GA towards more modern values and the obesity gender gap. In contrast, the association is negative with the overall obesity prevalence and the obesity prevalence for both sexes. This finding is original since the existing literature generally associates promoting women's empowerment with a decrease in the obesity gender gap and an increase in the global obesity prevalence (except for a slight decrease in HICs, particularly for women). Next, we identify nonlinearities in these relationships and a U-inverted shape association, particularly concerning women's prevalence of obesity and the obesity gender gap. This second finding aligns with the literature advocating reducing gender inequalities to close the gender obesity gaps. It helps us to understand the reversal in the obesity gradient for women. Finally, we made another interesting finding by analyzing the interactive effects between GA and countries' economic development. We find that changes towards more progressive/feminist values in gender attitudes developing with the economic development process effectively reduce the prevalence of obesity among women and the obesity gender gap but increase the obesity risk among men. At high levels of gender-egalitarian attitudes, we observed a slight decline in the prevalence of obesity among women accompanied by an upward trend among men. This result suggests that the burden of obesity shifts from women to men, transitioning from the "weight of patriarchy" to what we will call the "weight of modernity." More broadly, obesity gaps are narrowing in the general context of rising obesity rates.

To our knowledge, this article significantly contributes to the existing literature in several aspects. First, this study stands out from others because it is the first to highlight the importance of gender role attitudes as a sociocultural determinant of the obesity epidemic, providing essential insights into the history of the nutritional transition. Thanks to this approach, our research allows us to delve deeper into understanding the reduction of the gender obesity gap and its underlying mechanisms. From a methodological point of view, it is also the first study to offer econometric evidence on this topic by addressing endogeneity issues and using a large sample of countries.

The paper is organized in the following way. Section 2 draws an overview of the literature on the subject. Section 3 exposes the Data, and Section 4 gives some stylized facts. Section 5 exposes the econometric framework. Finally, Section 6 reports the results, and Section 7 concludes.

2. Related literature

In this section, we provide a general overview of studies that have explored the links between obesity and gender issues, either from a micro or macroeconomic perspective.

At the microeconomic level, we can say that the study closest to our research question is that of He & Xie (2022), which examines the influence of gender role attitudes on women's risk of obesity in China. In their article, the authors investigate how gender attitudes impact the obesity gender gap and explore its underlying mechanisms. In a few words, their results reveal that traditional gender role attitudes increase the obesity risk among Chinese women by reducing their economic status and labor force participation while having no significant effect on men. International organizations seem to share previous conclusions by promoting a better economic and social insertion of women through the concept of "women's empowerment," which we will summarize as a decline in "traditional" GA on gender roles toward "modern" GA. Nevertheless, it is worth noting that the relationship between gender, obesity, and women's empowerment is more complex than previously suggested. For instance, in East Africa, an increase in women's empowerment contributes to increasing women's BMI (Jones et al., 2020). Otherwise, in the Indian context, promoting better women's empowerment may be associated with better or worse women's BMI outcomes. It appears that, locally, women's nutritional status outcomes depend more on the acceptance or rejection of a decline in gender discrimination, transcribed through the degree of domestic violence against women (Alvarez-Saavedra et al., 2023). The results of research into the relationship between gender and obesity are, therefore, ambiguous, influenced both by the measures of gender inequality used, by contextual factors and by the level of economic development of countries. To give a more general overview of these results, Ameye & Swinnen (2019) have systematically examined the relationships between obesity, income and gender between and within different countries. Their results conclude that women are more obese than men in LICs, a risk that increases in MICs but disappears in HICs.

From a macroeconomic perspective, Wells et al. (2012) argue that the gender gap in obesity is deeply influenced by gender inequality, even more so than wealth inequality. Using the Gender Inequality Index (GII), which includes three dimensions - women's reproductive health, empowerment (including share of parliamentary seats and educational attainment) and labor force participation - the authors show that the obesity gender gap is more pronounced in countries with high gender inequality and low GDP. Garawi et al. (2014), albeit more

cautiously, support this finding and associate the obesity gender gap with two of the three measures of gender inequality used. Finally, more recent research produced by Costa-Font & Györi (2020) examines 190 countries over 41 years (1975-2016) and assesses the impact of women's empowerment on the gender obesity gap while controlling for endogeneity issues (Costa-Font & Györi, 2020). The authors use, in their work, two measures of women empowerment: female labor market participation and the share of female members in parliament. First, the results confirm that women's empowerment reduces the excess prevalence of women's obesity, but only in the Middle East and North Africa (MENA) region. Otherwise, they point out another interesting finding: the reduction in the gender obesity gap is mainly driven by an increase in men's prevalence of obesity, with no corresponding decline for women. We conclude by saying that the results of this study have caught our attention because they make it possible to realize that the most important aspect of the fight against the obesity epidemic is probably not only the reduction of the obesity gap between the sexes. Instead, it seems crucial to understand and address the evolution of obesity prevalence in both sexes in terms of the influence of gender role attitudes.

Briefly, our previous review provides evidence that the obesity gender gap can be attributed to traditional values about gender roles, as observed in China. In agreement with this finding, promoting women's empowerment can be associated with a decrease in women's obesity, as shown in the MENA and India regions, for instance. In other areas, such as East Africa and India, an increase in women's empowerment may also lead to an increase in women's risk of obesity. In our opinion, these different results highlight the need to consider all women's empowerment multidimensional aspects and their implications according to the context where it takes place. For instance, women's empowerment implies several economic changes (*e.g.*, women's economic integration into the formal labor market), demographic shifts (*e.g.*, the decline in fertility), and sociocultural transformations (*e.g.*, implementing feminist gender equality laws). All these simultaneous changes in women's empowerment and the reduction of gender inequalities should be taken into account to provide reliable information on the evolution of gender inequalities and their impact on obesity. Apart from these specific and regional effects, we also highlighted that the female burden appears to follow a non-linear pattern, diminishing with the increase in gender-egalitarian values and societies' economic development. One advanced explanation is that the reduction in the obesity gender gap is mainly due to men catching up in obesity prevalence. However, few studies have examined how changes in gender inequality might affect obesity prevalence by sex over time. More

research is therefore needed to draw more general conclusions from cross-sectional analyses that not only explain the evolution of the gender gap in obesity but also shed light on the global rise in obesity prevalence. Based on these observations, this article aims to fill these gaps in the literature.

3. Data

Our empirical analysis is based on data from the WHO Global Health Observatory and World Bank Open Data databases. Overall, our final panel dataset contains 4536 observations from 168 countries worldwide over 27 years (1990-2016), providing the necessary statistical power to investigate our research question. The entire list of countries included in the study is available in the Appendix in Table A3.1.

3.1 Dependent variables: Obesity prevalence and the obesity gender gap

We collected data on the prevalence of adult obesity (BMI > 30 kg/m²; total, men and women) from various countries across a wide range of economic development. These data come from WHO's calculations, which used the Bayesian hierarchical model to estimate countries' trends over the period from 2416 population-based studies, pooling height and weight measurements from 128.9 million participants aged five years and older (Abarca-Gómez et al., 2017). We also created a variable accounting for the obesity gender gap, defined as the absolute difference (in percentage points) between female and male obesity rates, measuring a gap to the disadvantage of women.

3.2 Predictors: Gender Attitudes (GA)

Previous data has been merged with two different measures of changes in GA. The first indicator of GA used is the Women, Business and the Law (WBL) index created by a World Bank group project. The WBL index, available for 190 countries from 1971 to 2021, is a composite measure of eight scored indicators²⁶ that range from 0 to 100, with higher scores indicating more gender-equal laws. The second indicator of GA used is a synthetic index based

²⁶ The eight-scored indicators concern laws in favor of equality of opportunity for women regarding mobility, workplace, salary, marriage, parenthood, entrepreneurship, assets, and pension. For more information about the methodology for data collection, scoring, and analysis: <http://wbl.worldbank.org> (accessed on : 13/10/2023).

on a Principal Component Analysis (PCA). This PCA-based index, also ranging from 0 to 100, combines three factors underlying the transformation of GA over time: the decline in the female fertility rate, the increase in female labor force participation, and the promotion of gender-equal laws (WBL). Based on the criterion of eigenvalues greater than 1, we retained the first component of the PCA, accounting for 58.74% of the total dataset inertia. More details about PCA's statistics are available in Table A3.2 in the Appendix.

3.3 Control variables

Based on the World Bank's open data databases, we distinguish two categories of control variables. This distinction in terms of covariates is inspired by the dichotomy of Fox et al. (2019), which distinguishes "modernization" and "globalization" as two potential determinants of the observed obesity trends. The first set of variables we use refers to what Fox et al. (2019) call the "modernization theory," which is, in other words, the dietary transition theory proposed by Popkin (1999). From Fox et al. (2019) point of view, this "modernization theory" refers to a positive economic development process that includes factors such as urbanization, the promotion of women's rights and democratization. Symbolized by the growth of gross domestic product (GDP), it leads to social and political change, which also leads to health changes, sometimes toward unhealthy lifestyles. In order to capture this vision of "modernization" of societies (including economic and social dimensions of progress), we collected data on GDP per capita at purchasing power parity (PPP) (constant 2017 US dollars) and life expectancy at birth. These determinants are widely used in the obesity literature and have minimal missing data in our database. The second set of variables we use refers to what Fox et al. (2019) call the "dependency/world systems theory," which refers to globalization as a process of "Westernization" of societies, creating a dependence on the global South from the global North (through economic disadvantages). According to Fox et al. (2019), economic globalization, particularly trade liberalization, are external factors influencing countries' consumption of unhealthy foods. To capture this other vision of societies' economic and social evolution, we included variables related to fossil fuel energy consumption of countries (% of total), foreign direct investment (FDI) (net inflows in % of GDP) and unemployment levels (% of the total labor force). Since these variables are less commonly used in the obesity literature and have more missing values than previously mentioned determinants, we used them as robustness checks.

4. Methods

We run time-individual fixed effects (FE) regressions to estimate the association between the two measures of GA mentioned earlier and our different obesity outcomes. Precisely, the study focuses on four dependent variables related to obesity, namely (a) the obesity gender gap, b) the global prevalence of obesity, c) and d) the obesity prevalence for both sexes, separately. We test three regression models: **[1]** a linear specification; **[2]** a quadratic specification to explore potential nonlinearity in the relationship; **[3]** a specification with an interaction term to investigate how the relationship may vary based on countries' levels of GDP. The regression specifications take the following form:

$$\mathbf{[1]} \quad O_{it} = \alpha_0 + \alpha_1 GA_{it} + \alpha_2 \log GDP_{it} + \alpha_3 \log GDP_{it}^2 + \alpha_4 \log LE_{it} + \rho W_{it} + \alpha_i + \alpha_t + \varepsilon_{it}$$

$$\mathbf{[2]} \quad O_{it} = \beta_0 + \beta_1 GA_{it} + \beta_2 GA_{it}^2 + \beta_3 \log GDP_{it} + \beta_4 \log GDP_{it}^2 + \beta_5 \log LE_{it} + \varphi W_{it} + \vartheta_i + \vartheta_t + \theta_{it}$$

$$\mathbf{[3]} \quad O_{it} = \gamma_0 + \gamma_1 GA_{it} + \gamma_2 \log GDP_{it} + \gamma_3 GA_{it} * \log GDP_{it} + \gamma_4 \log LE_{it} + \chi W_{it} + \Omega_i + \Omega_t + E_{it}$$

Where O refers to the obesity outcome considered for country i ($i=1 \dots n$) at time t ($t=1 \dots T$); GA to our variable of interest (*i.e.*, the WBL index or the PCA-based index); $\log GDP$ to GDP measured in natural logs; $\log LE$ to life expectancy measured in natural logs; W_{it} to a vector of control variables included for robustness checks (unemployment, fossil fuel energy consumption and FDI); α_i , ϑ_i , and Ω_i to country-specific fixed effects; α_t , ϑ_t , and Ω_t to year-specific fixed effects; ε_{it} , θ_{it} and E_{it} to overall error terms.

In addition, we pay attention (as much as possible) to a key concern of economists, which is the rigorous identification of causal relationships in their research. First, in panel data, our fixed effects models already allow us to control for a number of unobservable factors related to individual and temporal heterogeneity. Second, while reverse causality is typically a critical issue in empirical studies, as demonstrated in another paper on this topic (*i.e.*, He & Xie, 2022), the source of concern for this point seems weak in this paper. As gender attitudes are part of a socialization process, we can hypothesize that they are relatively stable in the short term and over time (*e.g.*, Schober & Scott, 2012). In other words, if GA can influence obesity rates, the reverse is assumed to be implausible. Nevertheless, we must always acknowledge the possibility of estimation bias due to omitted variables, such as the type of political regimes put

in place (Bauernschuster & Rainer, 2012), historical periods of famine (*e.g.*, China between 1958 and 1961), and previous family background that influences how parents raise their children (Lareau, 2002). Thus, we adopt an instrumental variable (IV) strategy to reinforce our results' robustness.

In the first econometric model specification [1], we use two instruments for GA: the sex ratio at birth (measuring the traditional preference for sons) and the proportion of women in the population aged 15 and older living with HIV in percent (a reflection of evolving social behaviors). The sex ratio at birth intends to capture the intensity of fertility behavior that traditionally favors sons (Guilmoto, 2012), consequently negatively correlated with egalitarian GA. On the other hand, higher HIV prevalence among women is expected to correlate negatively with egalitarian GA because societies tend to adopt safer sexual practices as they develop, leading to reduced HIV rates (*e.g.*, Ahmed et al., 2001; Weller et al., 1996). Moving to the second specification [2], we maintain these instruments and introduce an additional one for the quadratic term. This new instrument involves the interaction between the proportion of women in the population aged 15 and older living with HIV and the global HIV incidence (per 1,000 uninfected population). In the third specification [3], we again use the sex ratio at birth as an instrument for GA. For the interaction term (GA*logGDP), we use a set of two instruments, tailored to the specific dependent variable under study, either the gender gap in obesity or obesity prevalence. These instruments are selected based on their significance and expected relationship in the first-stage regressions. For the gender gap in obesity, we introduce two instruments for the interaction term: the sex ratio at birth and the proportion of women living with HIV, both interacting with gross capital formation (% of GDP) as an instrument for GDP. For obesity prevalence, we use the sex ratio at birth and the proportion of women living with HIV, both interacting with research and development expenditure (% of GDP) as an instrument for GDP. This instrumental strategy helps us gain more precise insights into the relationship between gender attitudes and obesity outcomes.

Methodologically, we try to ensure that our instrumental strategy satisfies the exclusion restriction condition (overidentification test) and that instruments are good predictors of endogenous variables (under-identification test; first-stage regressions significant and with the expected sign). We also pay attention to the possibility of weaknesses in our instruments (test for weak instruments through the Staiger criterion). Overall, our instrumental strategy is considered relevant, respecting (in the majority of cases) the criterion of exogeneity of

instruments²⁷. Although the tests seem satisfactory, we must nevertheless mention the existence of a possible theoretical questioning of our instruments based on the prevalence and incidence of HIV²⁸, which the literature links to the individuals' BMI (*e.g.*, Bailin et al., 2020; Keithley et al., 2009). Besides, the Staiger criterion indicates that our instrumental strategy has some weaknesses for the linear and quadratic specification, in particular. We, therefore, interpret the IV results cautiously and mainly use them as robustness checks of FE estimations results. In the Appendix, Tables A3.3 - A3.7 provide a detailed report of the IV methodology used.

5. Results

5.1 Descriptive statistics and stylized facts

Table 3.1 presents descriptive statistics for each of the variables considered in the study, focusing on the years 1990 and 2016. The statistics are also presented according to the income group levels of the countries. In the Appendix, Table A3.12 details these same statistics by country over the entire period.

Table 3.1: Descriptive statistics.

	WBL index (100-point score)		PCA-based index (100-point score)		Gender obesity Gap (in %)		Obesity (in %), total		Obesity (in %), men		Obesity (in %), women	
	1990	2016	1990	2016	1990	2016	1990	2016	1990	2016	1990	2016
All sample	53.75	73.26	53.08	72.13	5.95	7.24	9.32	18.59	6.18	14.68	12.14	21.92
Countries by income groups												
Low	47.70	66.56	44.48	62.48	3.14	7.88	2.94	7.91	1.28	3.72	4.42	11.60
Low-middle	52.55	66.59	51.92	65.07	7.78	8.88	10.89	15.24	6.72	10.43	14.50	19.31
Upper-middle	51.90	74.01	53.25	73.44	9.44	9.99	14.20	23.25	9.24	17.84	18.68	27.83
High	68.32	83.05	69.94	83.46	4.19	2.56	13.20	23.90	11.13	22.50	15.32	25.07

Note: The classification of countries by income groups is based on the World Bank standards.

Source: Author's calculations.

First, we observe an increase in the obesity gender gap between 1990 and 2016 (from 5.95% to 7.24%) and the global prevalence of obesity (from 9.32% to 18.59%). This trend is consistent for both sexes, with obesity rates rising from 6.18% to 14.68% for men and 12.14% to 21.92% for women, respectively. Simultaneously, the indicators of GA increased from 53.08 to 72.13 for the PCA-based index and from 53.75 to 73.26 for the WBL index (on a scale of 100 points).

²⁷ One exception is the rejection of the null hypothesis that the "over-identifying restrictions are valid" for the quadratic specification with the prevalence of obesity in women as the dependent variable, where the WBL is instrumented. See Table A3.4 in the Appendix.

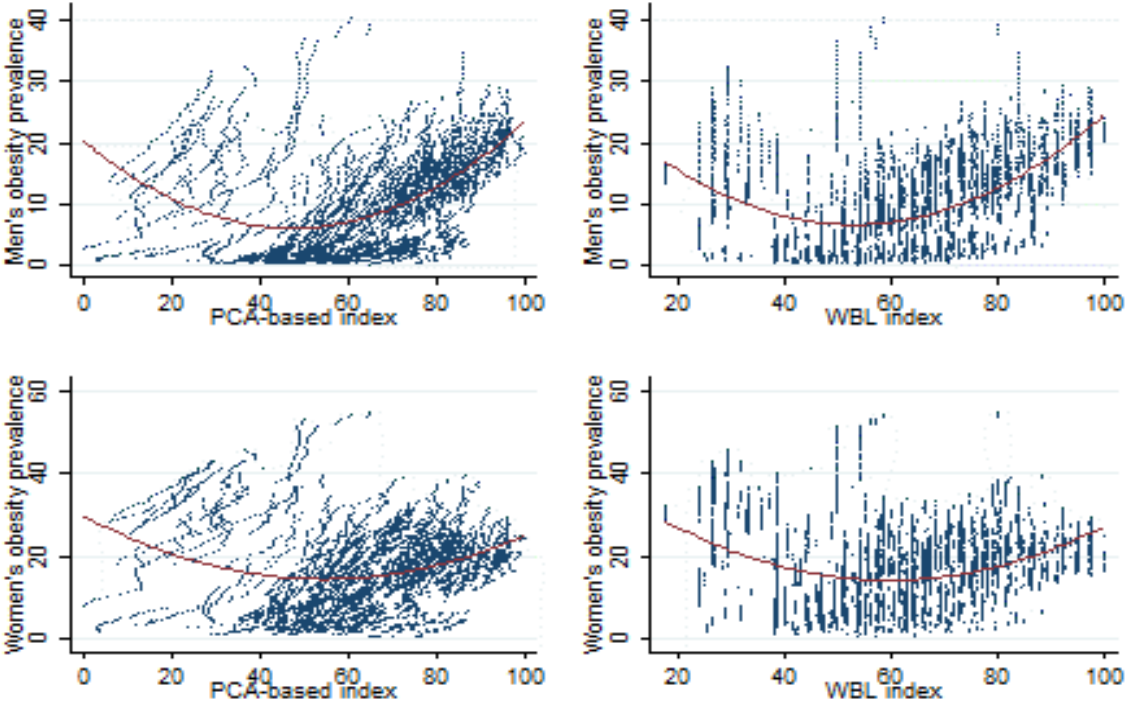
²⁸ At present, we have not found the best possible instrument; attitudes towards gender roles are closely linked to a number of variables, which in turn are linked to the BMI of the individuals considered.

These findings suggest a positive relationship between changes in GA towards more gender-egalitarian values, the obesity epidemic, and an increase in the obesity gender gap. These preliminary results confirm our initial hypothesis that gender role attitudes could be important determinants of the obesity epidemic and gender inequalities in malnutrition.

Second, with a focus on results depending on the level of economic development of the countries, we remark that the gender obesity gap decreases in HICs. In these countries, in particular, women's obesity prevalence is slightly decreasing while men's obesity prevalence is progressively increasing. Put differently, we progressively observe a U-inverted association regarding women's obesity prevalence, while we fail to see this pattern for men. Besides, more egalitarian GA increased with the economic development of countries. This second result suggests that "modern" gender role attitudes are positively associated with reducing women's excess obesity at the upper stages of economic development. Overall, these results confirm our hypothesis that the transformation of GA is linked to the reversal of the SES-obesity gradient for women and a shift in the obesity risk from women to men.

To go further, we present below the quadratic predictions fit plots of the obesity prevalence by sex (Fig. 3.1) and gender obesity gaps (Fig. 3.2) correlated with our two measures of GA, respectively.

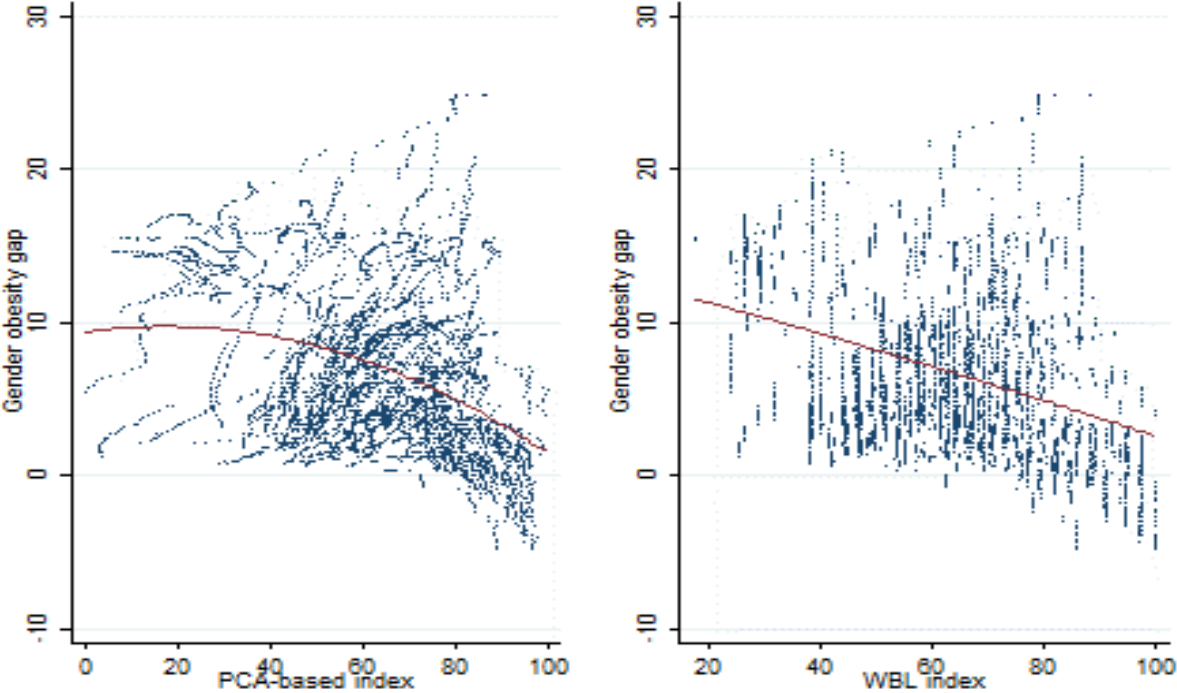
Figure 3.1. Prevalence of obesity (by sex) correlated with GA's indicators (quadratic prediction fit plots).



Source: Authors' calculations.

Figure 3.1 indicates a U-shape relationship for obesity prevalence among both sexes. Thus, we can suppose by graphical visualization that changes in gender role attitudes are decisive in explaining the global increase in obesity. We also emphasize that the shift from a negative to a positive association is more pronounced among men than women.

Figure 3.2 Gender obesity gaps correlated with GA's indicators (quadratic prediction fit plots).



Source: Authors' calculations.

Figure 3.2 displays a U-inverted shape relationship between the PCA-based index and the gender obesity gap. Conversely, we observe a negative relationship between the WBL index and the gender obesity gap. These graphical results align with the existing literature, linking women's excess in obesity to "traditional" GA. Previous findings also highlight that the different dimensions of changes in GA have varying effects on the evolution of the gender gap. While the WBL index is directly associated with a decrease in the obesity gender gap, the PCA-based index suggests a U-inverted association with a reduction of the obesity gender gap above a certain threshold of GA.

To sum up, these preliminary findings suggest a reduction in the obesity gender gap associated with more "modern" GA values and a reversal in the obesity gradient for women at the later stages of economic development. In the long run, we may hypothesize that this reduction in the obesity gender gap may be linked to an increase in the prevalence of obesity among men, which could potentially be more significant than the decline in obesity prevalence among women. The

following section will examine these initial conclusions econometrically and attempt to establish causation in these results.

5.2 Econometric estimates

Tables 3.2 and 3.3 present time-individual fixed effects (reg.1, 3, 5, 7, 9, 11) and IV fixed effects (reg. 2, 4, 6, 8, 12) estimates for the WBL and PCA-based indexes, respectively. In these estimates, we use the first set of control variables described in the data section (GDP per capita and life expectancy at birth). We detail below the FE results for Eq. 1, Eq. 2 and Eq. 3, controlling for their robustness with IV fixed effects results. IV fixed effects results intend to strengthen the persuasiveness of our findings by addressing endogeneity concerns. Overall, although our instrumental strategy may have limitations, the results are roughly similar between the different indicators of GA considered and FE or IV models.

The FE estimates of Eq.1 (linear specification) reveal that promoting gender-egalitarian laws as measured by the WBL index does not significantly affect the obesity gender gap. However, when considering changes in GA from a multidimensional perspective using the PCA-based index, we observe an increase in the obesity gender gap (1). Specifically, a 10-percentage point increase in the PCA-based index is associated with a 0.39 percentage point increase in the obesity gender gap (significant at the 10% level). Regarding obesity prevalence, we find a negative association between the WBL index and the total prevalence of obesity (7), particularly among men (13) (significant at the 10% level). However, we do not show evidence of such an association between the more comprehensive PCA-based index and the total obesity prevalence (7), neither for men (13) nor women (19). These associations become clearer when we compare these results with the IV estimates. Eq. 1 demonstrates a positive association between both indicators of GA and the obesity gender gap (2). This result is coherent with the descriptive statistics of section 6.1, which show an increase in the obesity gender gap of 1.25 percentage points from the 1990s to 2016, concomitantly to changes toward "modern" GA. Conversely, the result seems counterintuitive to the existing literature, indicating that reducing gender inequalities should theoretically lead to a decrease in the obesity gender gap. Besides, the results show a negative association between indicators of GA and obesity prevalence (8), with stronger effects observed for men (14) compared to women (20). To summarize these results, the linear specification model points out that in our sample, changes in GA are positively correlated to an increase in the obesity gender gap. This obesity gender gap increase seems mainly due to a

greater decrease in obesity prevalence among men than women. However, in line with the literature, we hypothesize that this linear specification is not appropriate to study the gender obesity gradient, so we deepen these findings with the results from the quadratic specification. As part of the FE estimates of Eq. 2 (quadratic specification), they reveal non-linear associations, adding an interesting dimension to the previous results. First, we observe a U-inverted-shaped association between the two indicators of GA and the obesity gender gap (3) (significant at the 1% level). Specifically, the turning points for these associations are located at the 39th percentile for the WBL index and the 54th percentile for the PCA-based index. This U-inverted-shaped trend is explained by a similar association observed for women's prevalence of obesity (21), whose turning points are situated at the 18th percentile of the WBL index and the 41st percentile of the PCA-based index (significant at the 1% level). Besides, this U-inverted trend is also explained by a U-shaped association between men's obesity prevalence (15) and the WBL index (significant at the 1% level), with a turning point at the 87th percentile. However, no significant association is found with the PCA-based index. Finally, these results, disaggregated by sex, reveal a global U-inverted association between the total prevalence of obesity (9) and the PCA-based index, with a turning point at the 34th percentile (significant at the 5% level). However, this type of association is not significant for the WBL index. Regarding IV estimates, they confirm the presence of non-linear associations in a U-inverted trend between the two indicators of GA and women's prevalence of obesity (22). Results also emphasize a U-inverted-shaped association between the obesity gender gap and the WBL index (4), not significant for the PCA-based index but with the expected sign. As part of the total obesity prevalence, no significant results are highlighted, possibly due to the heterogeneity of the results by sex. In conclusion, and based on previous findings, the quadratic specification model highlights a U-inverted-shaped association between the indicators of GA and the obesity gender gap, which seems to follow the gradient observed in women's obesity prevalence essentially. Nevertheless, the effects of changes in GA on men's obesity prevalence are unclear, like the evolution of the total obesity prevalence.

To go further, the FE estimates of Eq. 3 (interacted specification) present results that combine changes in GA with the economic development of countries. These results are significant for both indicators of GA examined and evidence a decrease in the obesity gender gap (5) and an increase in overall obesity prevalence (11), particularly among men (17) (significant at the 1% level). Regarding women, the results show a negative association between the WBL index and women's obesity prevalence (23) (significant at the 10% level), although this association is not

significant for the PCA-based index. All these effects' inflection points occur before reaching the lowest log of GDP in the observed sample, suggesting that these associations do not reverse at that point. Through IV estimates, we can confirm a positive association between our measures of GA and men's obesity prevalence (18), a negative association for women's obesity prevalence (24), and a reduction in the obesity gender gap (6). However, we no longer observe any significant effect on the total obesity prevalence (12). In a few words, with the promotion of more gender-egalitarian values during the economic development process of countries, gender inequalities in obesity tend to narrow as obesity prevalence increases among men and slightly decreases for women, with no significant effect on the global obesity prevalence.

Regarding the control variables, the log of GDP and its squared term yield consistent results demonstrating a U-inverted association concerning the obesity gender gap, in line with other studies (*e.g.*, Costa-Font & Györi, 2020). On the other hand, the log of GDP shows a U-shaped association concerning obesity prevalence, which is also supported by the existing literature (*e.g.*, Egger et al., 2012). Moreover, we remark, in the long run, that the increase in economic development (measured by the log of GDP) positively affects the prevalence of obesity among men, whereas not significantly for women. This result also aligns with the literature, highlighting a reversal in the SES-obesity gradient at the upper stages of economic development, notably for women who adopt better behaviors face obesity risk (*e.g.*, Sobal & Stunkard, 1989; McLaren, 2007). Finally, and as expected, improvements in the log of life expectancy are negatively associated with the rise of obesity. However, we do not find any significant association with the obesity gender gap. These results validate the specification of our econometric models and provide confidence in the robustness of our findings.

As part of robustness checks, and as described in the data section, we include a second set of variables (fossil fuel energy consumption of countries, FDI levels, and unemployment levels) to control for omitted variable bias and address potential endogeneity issues. Overall, the results are quite similar to the previous conclusions, further supporting the reliability of our findings. In the Appendix, Tables A3.8 - A3.11 entirely report these results.

Table 3.2: Impact of GA (considering the WBL index) by dependent variables (FE vs. IV estimates with the three specifications of the model).

VARIABLES	Gender obesity gap						Prevalence of obesity (global)					
	(1) FE Linear	(2) IV Linear	(3) FE Quadratic	(4) IV Quadratic	(5) FE Interacted	(6) IV Interacted	(7) FE Linear	(8) IV Linear	(9) FE Quadratic	(10) IV Quadratic	(11) FE Interacted	(12) IV Interacted
Log (GDP)	17.951*** (3.514)	18.848*** (1.102)	11.056*** (2.922)	2.771 (6.426)	3.905*** (0.470)	4.105*** (0.949)	-8.655*** (2.733)	-10.586*** (1.250)	-9.331*** (3.010)	-12.538*** (4.320)	-2.176*** (0.423)	-1.483** (0.637)
Log(GDP_sqr)	-1.057*** (0.207)	-1.122*** (0.066)	-0.648*** (0.177)	-0.171 (0.383)			0.452*** (0.160)	0.584*** (0.073)	0.492*** (0.176)	0.696*** (0.258)		
Log (LE)	1.370 (2.293)	1.410 (1.118)	1.032 (1.856)	-0.078 (1.137)	-0.625 (1.507)	-1.902 (1.650)	-7.022*** (2.396)	-6.234*** (1.967)	-7.055*** (2.416)	-5.866*** (1.835)	-6.828*** (2.210)	-7.259*** (1.925)
WBL index	0.004 (0.015)	0.176*** (0.041)	0.354*** (0.046)	1.114*** (0.340)	0.636*** (0.068)	0.951*** (0.157)	-0.022* (0.012)	-0.241*** (0.057)	0.012 (0.042)	-0.105 (0.213)	-0.221*** (0.048)	-0.135 (0.121)
<i>WBL index</i> ²			-0.003*** (0.000)	-0.007*** (0.002)					-0.000 (0.000)	-0.000 (0.002)		
WBL index * log (GDP)					-0.071*** (0.007)	-0.088*** (0.015)					0.022*** (0.006)	0.010 (0.011)
Constant	-74.740*** (12.092)		-55.629*** (10.728)		-26.012*** (5.776)		80.252*** (12.723)		82.125*** (13.302)		57.997*** (8.783)	
Observations	4,260	4,074	4,260	3,167	4,260	3,761	4,260	4,074	4,260	3,167	4,260	3,446
Number of countries	163	157	163	122	163	151	163	157	163	122	163	138
Adjusted R-squared	0.266	-0.231	0.381	-0.561	0.445	-0.022	0.882	0.711	0.882	0.841	0.883	0.857
F-statistic		9.04		4.447		12.20		9.04		4.447		33.37

VARIABLES	Prevalence of obesity (men)						Prevalence of obesity (women)					
	(13) FE Linear	(14) IV Linear	(15) FE Quadratic	(16) IV Quadratic	(17) FE Interacted	(18) IV Interacted	(19) FE Linear	(20) IV Linear	(21) FE Quadratic	(22) IV Quadratic	(23) FE Interacted	(24) IV Interacted
Log (GDP)	-18.358*** (3.346)	-20.794*** (1.609)	-15.496*** (3.380)	-16.043** (6.570)	-4.159*** (0.484)	-6.374*** (0.805)	-0.408 (3.105)	-1.946* (1.154)	-4.440 (3.295)	-13.272*** (4.015)	-0.254 (0.480)	2.521*** (0.644)
Log(GDP_sqr)	1.026*** (0.199)	1.195*** (0.095)	0.856*** (0.201)	0.909** (0.392)			-0.031 (0.179)	0.073 (0.067)	0.208 (0.192)	0.738*** (0.239)		
Log (LE)	-7.394** (3.108)	-6.621*** (2.422)	-7.254** (2.975)	-5.621*** (2.179)	-6.245** (2.466)	-2.347 (1.636)	-6.024*** (1.938)	-5.211*** (1.497)	-6.222*** (1.958)	-5.699*** (1.618)	-6.870*** (2.014)	-10.447*** (2.273)
WBLINDEX	-0.024* (0.014)	-0.344** (0.069)	-0.170** (0.049)	-0.599* (0.339)	-0.552*** (0.057)	-1.048*** (0.150)	-0.021 (0.014)	-0.169*** (0.053)	0.184*** (0.047)	0.515*** (0.188)	0.084 (0.059)	0.588*** (0.119)
<i>WBL index</i> ²			0.001*** (0.000)	0.003 (0.003)					-0.002*** (0.000)	-0.004*** (0.002)		
WBL index * log (GDP)					0.060*** (0.006)	0.100*** (0.014)					-0.012* (0.007)	-0.062*** (0.011)
Constant	118.974*** (14.353)		111.040*** (14.525)		69.978*** (9.541)		44.234*** (13.316)		55.411*** (13.708)		43.967*** (8.258)	
Observations	4,260	4,074	4,260	3,167	4,260	3,446	4,260	4,074	4,260	3,167	4,260	3,446
Number of countries	163	157	163	122	163	138	163	157	163	122	163	138
Adjusted R-squared	0.831	0.448	0.835	0.599	0.850	0.694	0.870	0.793	0.877	0.862	0.872	0.823
F-statistic		9.04		4.447		33.37		9.04		4.447		33.37

Source: Author's calculations. Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3.3: Impact of GA (considering the PCA index) by dependent variables (FE vs. IV estimates with the three specifications of the model).

VARIABLES	Gender obesity gap				Prevalence of obesity (global)							
	(1) FE Linear	(2) IV Linear	(3) FE Quadratic	(4) IV Quadratic	(5) FE Interacted	(6) IV Interacted	(7) FE Linear	(8) IV Linear	(9) FE Quadratic	(10) IV Quadratic	(11) FE Interacted	(12) IV Interacted
Log (GDP)	17.724*** (3.372)	15.952*** (1.241)	13.268*** (3.133)	7.956 (9.558)	4.691*** (0.541)	6.246*** (1.520)	-8.496*** (2.736)	-6.723*** (1.640)	-10.700*** (2.835)	-17.116*** (5.078)	-2.524*** (0.511)	-1.614** (0.721)
Log(GDP_sqr)	-1.042*** (0.200)	-0.929*** (0.074)	-0.767*** (0.189)	-0.432 (0.587)			0.440*** (0.161)	0.327*** (0.095)	0.577*** (0.166)	0.967*** (0.312)		
Log (LE)	1.246 (2.253)	0.634 (1.082)	0.686 (2.049)	-1.882 (2.047)	-1.397 (1.506)	-4.320* (2.236)	-7.064*** (2.341)	-5.208*** (1.948)	-7.341*** (2.502)	-6.392*** (2.405)	-6.548*** (2.139)	-7.052*** (1.946)
GA index	0.039* (0.020)	0.334*** (0.088)	0.270*** (0.068)	1.225** (0.619)	0.767*** (0.071)	1.231*** (0.227)	-0.002 (0.017)	-0.442*** (0.127)	0.113** (0.049)	0.139 (0.328)	-0.241*** (0.062)	-0.151 (0.131)
<i>GA index</i> ²			-0.002*** (0.001)	-0.003 (0.004)					-0.001** (0.000)	-0.003 (0.002)		
GA index * log (GDP)					-0.082*** (0.008)	-0.109*** (0.022)					0.027*** (0.007)	0.010 (0.012)
Constant	-75.286*** (11.960)		-62.200*** (10.643)		-31.336*** (5.818)		78.821*** (12.421)		85.293*** (13.232)		58.738*** (8.370)	
Observations	4,260	4,074	4,260	3,167	4,260	3,761	4,260	4,074	4,260	3,167	4,260	3,446
Number of countries	163	157	163	122	163	151	163	157	163	122	163	138
Adjusted R-squared	0.276	-0.386	0.341	-3.628	0.464	0.020	0.880	0.572	0.883	0.773	0.882	0.853
F-statistic		16.23		6.30		4.34		16.23		6.30		36.09

VARIABLES	Prevalence of obesity (men)				Prevalence of obesity (women)							
	(13) FE Linear	(14) IV Linear	(15) FE Quadratic	(16) IV Quadratic	(17) FE Interacted	(18) IV Interacted	(19) FE Linear	(20) IV Linear	(21) FE Quadratic	(22) IV Quadratic	(23) FE Interacted	(24) IV Interacted
Log (GDP)	-18.074*** (3.345)	-15.252*** (2.098)	-17.942*** (3.461)	-23.466*** (8.883)	-4.896*** (0.600)	-7.188*** (0.972)	-0.351 (3.032)	0.700 (1.441)	-4.675 (2.990)	-15.510*** (4.234)	-0.205 (0.555)	2.996*** (0.707)
Log(GDP_sqr)	1.007*** (0.198)	0.826*** (0.122)	0.998*** (0.205)	1.328** (0.546)			-0.036 (0.176)	-0.103 (0.084)	0.232 (0.176)	0.896*** (0.258)		
Log (LE)	-7.369** (3.103)	-5.146** (2.385)	-7.352** (3.115)	-5.440* (3.108)	-5.585** (2.424)	-1.458 (1.631)	-6.122*** (1.804)	-4.512*** (1.498)	-6.666*** (2.045)	-7.323*** (2.112)	-6.983*** (1.937)	-10.834*** (2.335)
GA index	-0.023 (0.020)	-0.635*** (0.162)	-0.030 (0.068)	-0.374 (0.580)	-0.638*** (0.068)	-1.147*** (0.173)	0.016 (0.020)	-0.301*** (0.110)	0.241*** (0.050)	0.852*** (0.263)	0.128* (0.074)	0.645*** (0.121)
<i>GA index</i> ²			0.000 (0.000)	-0.002 (0.004)					-0.002*** (0.000)	-0.005*** (0.002)		
GA index * log (GDP)					0.070*** (0.008)	0.104*** (0.016)					-0.013 (0.008)	-0.067*** (0.012)
Constant	117.835*** (14.155)		117.448*** (14.689)		73.465*** (8.960)		42.549*** (12.927)		55.248*** (13.324)		42.129*** (8.173)	
Observations	4,260	4,074	4,260	3,167	4,260	3,446	4,260	4,074	4,260	3,167	4,260	3,446
Number of countries	163	157	163	122	163	138	163	157	163	122	163	138
Adjusted R-squared	0.830	0.194	0.830	0.082	0.852	0.717	0.870	0.720	0.880	0.822	0.871	0.833
F-statistic		16.23		6.30		36.09		16.23		6.30		36.09

Source: Author's calculations. Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6. Conclusion

From a macroeconomic perspective and based on an exhaustive sample of 168 countries over a large time window (1990-2016), this paper represents the first study to examine the relationship between changes toward "modern" / feminist gender role attitudes and the evolution of the obesity gender gap and the obesity prevalence for each sex. To achieve this goal, we employed time-individual fixed effects estimations that we then compared with the results of instrumental variable fixed effects estimations. Our analysis included various econometric models analyzing linear and non-linear relationships between GA and our obesity outcomes, as well as the interaction of GA with the economic development process of countries. Our investigations provide new insights into the sociocultural dynamic of the obesity epidemic and highlight interesting differences in the evolution of obesity risk between the sexes.

First, the literature has identified several factors that contribute to excess obesity in women, such as high fertility rates, restricted mobility, and low labor market participation due to patriarchal structures and traditional attitudes toward gender roles (De Soysa & Lewin, 2019). Our analysis shows that removing these constraints may not immediately reduce the gender gap in obesity. On a global scale, changing attitudes towards gender roles - characterized by declining fertility, increased female labor force participation, and the promotion of more egalitarian laws between the sexes - have contributed to a widening of the gender gap in obesity risk from the 1990s to 2016. Women continue to bear a heavier burden of obesity than men worldwide. As noted in other studies, it is possible that "traditional" beliefs about gender roles provide women with some protection against 'Western consumption habits' (such as eating out and access to high-calorie processed foods and bars), while empowerment exposes them to an obesogenic environment (Alvarez-Saavedra et al., 2023; Fox et al., 2019). Moreover, these positive changes for the betterment of women must be accompanied by the acceptance of new values by men in order to avoid an increase in domestic violence and the deterioration of women's conditions, which can affect their health. We can assume that the persistence of traditional beliefs about women's bodies, combined with modern factors that increase the risk of obesity, may temporarily expose women to a double burden of obesity, resulting from both their past circumstances and the ongoing changes they are experiencing. It is, therefore, crucial for policy to identify environmental factors that may contribute to obesity in women during this process of economic development and empowerment.

Second, our results show that more gender-equal laws (as measured by the WBL index) or more extensive changes in GA (using our PCA-based index) lead to a U-shaped association with women's obesity prevalence and the obesity gender gap. According to our results, reducing the gender gap is negatively correlated with women's obesity risk in the long run. In contrast, men's obesity prevalence seems to be influenced more by economic development and growth than by social change. This finding is consistent with a study in China (*i.e.*, He & Xie, 2022), which highlights that traditional gender attitudes only affect women's obesity risk but not men's. One hypothesis for this reversal of obesity among women is the existence of a women's intrasexual competition aiming to increase the chances of survival of their offspring, as proposed by Darwin (1871). To develop this idea further, we need to consider that food insecurity is a persistent challenge in developing countries, where access to food resources can be scarce. In this context, traditional gender roles prioritize the reproductive function of mothers to ensure the survival of the family over the years in a logic of "quantity." In these countries, obesity is culturally associated with motherhood, leading to a greater acceptance of higher BMI (Kanter & Caballero, 2012). In addition, men are often more engaged in energy-intensive physical activities than women who work at home in low-intensity physical activities, resulting in lower obesity rates for men but higher rates for women (Kanter & Caballero, 2012). Conversely, richer countries offer abundant resources and less competition for those resources. In this context, intrasexual competition between women can be explained in terms of 'quality' and the desire to have fewer children, which reduces the risk of obesity associated with motherhood. However, the costs of raising children in developed countries, including the expectation that they will climb the social ladder and the associated costs of education, lead women to propose their participation in the labor force, thereby reducing their obesity risk. In addition, women may be more influenced by media and societal expectations and public policy recommendations regarding ideal body size, leading to a preference for lower BMIs in these countries (Sánchez-Vaznaugh et al., 2009).

Third, we emphasize that when considering the combined impact of changes in GA with modernization and globalization, the gender obesity gap tends to narrow. In the long run, men's obesity prevalence tends to increase, whereas women's obesity prevalence decreases. However, we find that the absolute magnitude of the effects is more significant for men than women. In other words, the reduction in the gender obesity gap is primarily driven by the increased prevalence of obesity among men, and women's advantage does not fully compensate for men's disadvantages, which confirms previous findings in the literature (Costa-Font & Györi, 2020).

On that point, studies in the USA and Japan have demonstrated that unemployment rates disproportionately affect men rather than women (Emerson, 2011; Kakinaka & Miyamoto, 2012). In particular, unemployment potentially leads to increased obesity or unhealthy behaviors among unemployed men as opposed to women (Montgomery et al., 1998). Thus, new challenges in developed societies are more favorably received by women than men. One hypothesis is that these changes in gender roles are not entirely understood by men, with adverse consequences on them. Drawing a parallel with previous research that referred to women's obesity as the "weight of patriarchy" (Costa-Font & Györi, 2020), we can analogously suggest that men's obesity represents the "weight of modernity." Public policies must support and accompany these positive changes in women, encouraging them to promote and extend their concern for maintaining a healthy nutritional status to men. Without such policies, it will be challenging to reverse the upward trend of obesity, and women appear to play a crucial role in addressing this concern.

To conclude this work, there are certain limitations that we must mention. For example, due to a lack of data, we cannot control our estimates for ethnic factors that shape individuals' beliefs. We have also not taken into account factors that are not socially determined, such as those related to the intergenerational transmission of health. It would also be important for further research perspectives to understand how these gender role attitudes change other health inequalities, such as diabetes, hypertension and other diseases related to malnutrition and obesity, among adults and their children.

Appendix

Table A3.1: List of countries included in the study.

Afghanistan	Estonia	Mexico	Tonga
Albania	Eswatini	Mongolia	Trinidad and Tobago
Algeria	Ethiopia	Montenegro	Tunisia
Angola	Fiji	Morocco	Turkey
Argentina	Finland	Mozambique	Uganda
Armenia	France	Myanmar	Ukraine
Australia	Gabon	Namibia	United Arab Emirates
Austria	Gambia	Nepal	United Kingdom
Azerbaijan	Georgia	Netherlands	Tanzania
Bahamas	Germany	New Zealand	United States of America
Bahrain	Ghana	Nicaragua	Uruguay
Bangladesh	Greece	Niger	Uzbekistan
Barbados	Guatemala	Nigeria	Vanuatu
Belarus	Guinea	Norway	Venezuela
Belgium	Guinea-Bissau	Oman	Viet Nam
Belize	Guyana	Pakistan	Yemen
Benin	Haiti	Panama	Zambia
Bhutan	Honduras	Papua New Guinea	Zimbabwe
Bolivia	Hungary	Paraguay	
Bosnia and Herzegovina	Iceland	Peru	
Botswana	India	Philippines	
Brazil	Indonesia	Poland	
Brunei	Iran	Portugal	
Bulgaria	Iraq	Qatar	
Burkina Faso	Ireland	Republic of Korea	
Burundi	Israel	Republic of Moldova	
Cambodia	Italy	Russia	
Cameroon	Jamaica	Rwanda	
Canada	Japan	Samoa	
Cape Verde	Jordan	Sao Tome and Principe	
Central African Republic	Kazakhstan	Saudi Arabia	
Chad	Kenya	Senegal	
Chile	Kuwait	Sierra Leone	
China	Kyrgyzstan	Singapore	
Colombia	Laos	Slovakia	
Comoros	Latvia	Solomon Islands	
Congo	Lebanon	Somalia	
Costa Rica	Lesotho	South Africa	
Croatia	Liberia	Spain	
Cyprus	Libya	Sri Lanka	
Czechia	Lithuania	St. Lucia	
Côte d'Ivoire	Luxembourg	St. Vincent and the Grenadines	
Congo	Madagascar	Suriname	
Denmark	Malawi	Sweden	
Dominican Republic	Malaysia	Switzerland	
Ecuador	Maldives	Syria	
Egypt	Mali	Tajikistan	
El Salvador	Malta	Thailand	
Equatorial Guinea	Mauritania	Macedonia	
Eritrea	Mauritius	Togo	

Source: Author's calculations.

Table A3.2: Results from PCA about the GA index created.

Component	Eigenvalue	Proportion	Cumulative
Component 1	1.762	0.5874	0.5874
Component 2	0.965	0.3216	0.9091
Component 3	0.273	0.0909	1
Variables	Eigenvectors	Unexplained	
Fertility rate, total (births per woman)	-0.499	0.5605	
Labor force, female (% of the total labor force)	0.512	0.5376	
WBL index	0.699	0.1396	

Source: Author's calculations.

Table A3.3: Full set of instruments used by endogenous variables.

Endogenous variables	Instruments
<i>Linear specification :</i> Gender attitudes (GA)	1) The sex ratio at birth (male births per female births); 2) Women's share of the population ages 15 + living with HIV (%).
<i>Quadratic specification:</i> Gender attitudes (GA) + GA^2	1) The sex ratio at birth (male births per female births); 2) Women's share of the population ages 15 + living with HIV (%); 3) Women's share living with HIV * global incidence of HIV (per 1000 uninfected population).
<i>Interacted specification :</i> Gender attitudes + (GA * GDP)	1) The sex ratio at birth (male births per female births); 2) The sex ratio at birth (male births per female births) * gross capital formation (% of GDP) or research and development expenditure (% of GDP); 3) Women's share living with HIV * gross capital formation (% of GDP) or research and development expenditure (% of GDP).

Source: Author's calculations.

Table A3.4: Tests of instrument validity (WBL index).

Dependent variable	Gender obesity gap			Obesity prevalence (total)		
	Linear	Quadratic	Interacted	Linear	Quadratic	Interacted
Tests of over-identification (instrument exogeneity)						
<i>H0: Over-identifying restrictions are valid</i>						
Hansen J-statistic	0.894	0.054	1.276	0.782	2.448	1.126
Chi2 distribution p-value	0.345	0.816	0.259	0.376	0.118	0.289
Tests of under-identification (instrument relevance)						
<i>H0: Equations are under-identified</i>						
Kleibergen Papp rk LM statistic	31.068	17.559	45.786	31.068	17.559	81.496
Chi2 distribution p-value	0.000	0.000	0.000	0.000	0.000	0.000
Tests of weak identification						
<i>Weak if: Wald F-stat < Stock-Yogo test</i>						
Cragg-Donal Wald F-statistic	17.918	8.638	20.305	17.918	8.638	25.419
Stock-Yogo weak ID test critical values (10%)	19.93	13.43	13.43	19.93	13.43	13.43

Source: Author's calculations.

Dependent variable	Prevalence of obesity (men)			Prevalence of obesity (women)		
	Linear	Quadratic	Interacted	Linear	Quadratic	Interacted
Tests of over-identification (instrument exogeneity)						
<i>H0: Over-identifying restrictions are valid</i>						
Hansen J-statistic	0.402	1.943	2.235	2.117	3.104	0.030
Chi2 distribution p-value	0.526	0.163	0.135	0.1456	0.078	0.862
Tests of under-identification (instrument relevance)						
<i>H0: Equations are under-identified</i>						
Kleibergen Papp rk LM statistic	31.068	17.559	81.496	31.068	17.559	81.496
Chi2 distribution p-value	0.000	0.000	0.000	0.000	0.000	0.000
Tests of weak identification						
<i>Weak if: Wald F-stat < Stock-Yogo test</i>						
Cragg-Donal Wald F-statistic	17.918	8.638	25.419	17.918	8.638	25.419
Stock-Yogo weak ID test critical values (10%)	19.93	13.43	13.43	19.93	13.43	13.43

Source: Author's calculations.

Table A3.5: Tests of instrument validity (GA based on PCA).

Dependent variable	Gender obesity gap			The global prevalence of obesity		
	Linear	Quadratic	Interacted	Linear	Quadratic	Interacted
Tests of over-identification (instrument exogeneity)						
<i>H0: Over-identifying restrictions are valid</i>						
Hansen J-statistic	0.221	1.791	0.323	1.139	2.033	1.136
Chi2 distribution p-value	0.639	0.181	0.570	0.286	0.154	0.286
Tests of under-identification (instrument relevance)						
<i>H0: Equations are under-identified</i>						
Kleibergen Papp rk LM statistic	18.611	12.925	39.402	18.611	12.925	78.626
Chi2 distribution p-value	0.000	0.002	0.000	0.000	0.002	0.000
Tests of weak identification						
<i>Weak if: Wald F-stat < Stock-Yogo test</i>						
Cragg-Donal Wald F-statistic	11.111	5.916	16.088	11.111	5.916	29.759
Stock-Yogo weak ID test critical values (10%)	19.93	13.43	13.43	19.93	13.43	13.43

Source: Author's calculations.

Dependent variable	Prevalence of obesity (men)			Prevalence of obesity (women)		
	Linear	Quadratic	Interacted	Linear	Quadratic	Interacted
Tests of over-identification (instrument exogeneity)						
<i>H0: Over-identifying restrictions are valid</i>						
Hansen J-statistic	0.793	2.374	0.535	2.389	0.030	0.879
Chi2 distribution p-value	0.373	0.123	0.464	0.122	0.862	0.348
Tests of under-identification (instrument relevance)						
<i>H0: Equations are under-identified</i>						
Kleibergen Papp rk LM statistic	18.611	12.925	78.626	18.611	12.925	78.626
Chi2 distribution p-value	0.000	0.002	0.0002	0.000	0.002	0.000
Tests of weak identification						
<i>Weak if: Wald F-stat < Stock-Yogo test</i>						
Cragg-Donal Wald F-statistic	11.111	5.916	29.759	11.111	5.916	29.759
Stock-Yogo weak ID test critical values (10%)	19.93	13.43	13.43	19.93	13.43	13.43

Source: Author's calculations.

Table A3.6: First-stage regression results (GA based on PCA).

Dependent variables :	Gender obesity gap					Prevalence of obesity (total)				
	Linear GA index	Quadratic GA index <i>GA index</i> ²		Interacted GA index <i>GA index</i> * log (GDP)		Linear GA index	Quadratic GA index <i>GA index</i> ²		Interacted GA index <i>GA index</i> * log (GDP)	
Sex ratio at birth	-28.24*** (0.001)	-21.82** (0.047)	-2685.9* (0.094)	-18.81** (0.021)	-242.8*** (0.002)	-28.24*** (0.001)	-21.82** (0.047)	-2685.9* (0.094)	-20.99** (0.029)	-180.5* (0.067)
Women with HIV	0.0457*** (0.001)	0.0282 (0.135)	7.451*** (0.003)			0.0457*** (0.001)	0.0282 (0.135)	7.451*** (0.003)		
Women with HIV * Incidence of HIV		-0.00450*** (0.000)	-0.612*** (0.000)				-0.00450*** (0.000)	-0.612*** (0.000)		
Sex ratio at birth * RD									-0.0120** (0.018)	0.0820* (0.092)
Incidence of HIV * RD									0.00115*** (0.000)	0.00872*** (0.000)
Sex ratio at birth * Capital				-0.0942*** (0.000)	-0.966*** (0.000)					
Women with HIV * Capital				0.00253*** (0.000)	0.0215*** (0.000)					
Observations	4074	3167	3167	3761	3761	4074	3167	3167	3446	3446
F-stat	11.111	5.916	5.916	16.088	16.088	11.111	5.916	5.916	29.759	29.759

Dependent variables :	Prevalence of obesity (men)					Prevalence of obesity (women)				
	Linear GA index	Quadratic GA index <i>GA index</i> ²		Interacted GA index <i>GA index</i> * log (GDP)		Linear GA index	Quadratic GA index <i>GA index</i> ²		Interacted GA index <i>GA index</i> * log (GDP)	
Sex ratio at birth	-28.24*** (0.001)	-21.82** (0.047)	-2685.9* (0.094)	-20.99** (0.029)	-180.5* (0.067)	-28.24*** (0.001)	-21.82** (0.047)	-2685.9* (0.094)	-20.99** (0.029)	-180.5* (0.067)
Women with HIV	0.0457*** (0.001)	0.0282 (0.135)	7.451*** (0.003)			0.0457*** (0.001)	0.0282 (0.135)	7.451*** (0.003)		
Women with HIV * Incidence of HIV		-0.00450*** (0.000)	-0.612*** (0.000)				-0.00450*** (0.000)	-0.612*** (0.000)		
Sex ratio at birth * RD				-0.0120** (0.018)	0.0820* (0.092)				-0.0120** (0.018)	0.0820* (0.092)
Incidence of HIV * RD				0.00115*** (0.000)	0.00872*** (0.000)				0.00115*** (0.000)	0.00872*** (0.000)
Sex ratio at birth * Capital										
Women with HIV * Capital										
Observations	4074	3167	3167	3446	3446	4074	3167	3167	3446	3446
F-stat	11.111	5.916	5.916	29.759	29.759	11.111	5.916	5.916	29.759	29.759

Robust p-values in parentheses: *p<0.05, **p<0.01, ***p<0.001.
Source: Author's calculations.

Table A3.7: First-stage regression results (WBL index).

Dependent variables :	Gender obesity gap					Prevalence of obesity (total)				
	Linear WBL index	Quadratic WBL index WBL <i>index</i> ²		Interacted WBL index WBL index * log (GDP)		Linear WBL index	Quadratic WBL index WBL <i>index</i> ²		Interacted WBL index WBL index * log (GDP)	
Sex ratio at birth	-47.69*** (0.000)	-34.99** (0.018)	-5181.6** (0.014)	-40.96*** (0.000)	-490.4*** (0.000)	-47.69*** (0.000)	-34.99** (0.018)	-5181.6** (0.014)	-44.95*** (0.001)	-450.5*** (0.001)
Women with HIV	0.0916*** (0.000)	0.100*** (0.000)	15.66*** (0.000)			0.0916*** (0.000)	0.100*** (0.000)	15.66*** (0.000)		
Women with HIV * Incidence of HIV		-0.0105*** (0.000)	-1.170*** (0.000)				-0.0105*** (0.000)	-1.170*** (0.000)		
Sex ratio at birth * RD									-0.00369 (0.611)	0.177** (0.013)
Incidence of HIV * RD									0.00149*** (0.000)	0.0115*** (0.000)
Sex ratio at birth * Capital				-0.163*** (0.000)	-1.610*** (0.000)					
Women with HIV * Capital				0.00403*** (0.000)	0.0344*** (0.000)					
Observations	4074	3167	3167	3761	3761	4074	3167	3167	3446	3446
F-stat	17.92	8.64	8.64	20.31	20.31	17.92	8.64	8.64	25.42	25.42

Dependent variables :	Prevalence of obesity (men)					Prevalence of obesity (women)				
	Linear WBL index	Quadratic WBL index WBL <i>index</i> ²		Interacted WBL index WBL index * log (GDP)		Linear WBL index	Quadratic WBL index WBL <i>index</i> ²		Interacted WBL index WBL index * log (GDP)	
Sex ratio at birth	-47.69*** (0.000)	-34.99** (0.018)	-5181.6** (0.014)	-44.95*** (0.001)	-450.5*** (0.001)	-47.69*** (0.000)	-34.99** (0.018)	-5181.6** (0.014)	-44.95*** (0.001)	-450.5*** (0.001)
Women with HIV	0.0916*** (0.000)	0.100*** (0.000)	15.66*** (0.000)			0.0916*** (0.000)	0.100*** (0.000)	15.66*** (0.000)		
Women with HIV * Incidence of HIV		-0.0105*** (0.000)	-1.170*** (0.000)				-0.0105*** (0.000)	-1.170*** (0.000)		
Sex ratio at birth * RD				-0.00369 (0.611)	0.177** (0.013)				-0.00369 (0.611)	0.177** (0.013)
Incidence of HIV * RD				0.00149*** (0.000)	0.0115*** (0.000)				0.00149*** (0.000)	0.0115*** (0.000)
Sex ratio at birth * Capital										
Women with HIV * Capital										
Observations	4074	3167	3167	3446	3446	4074	3167	3167	3446	3446
F-stat	17.92	8.64	8.64	25.42	25.42	17.92	8.64	8.64	25.42	25.42

Robust p-values in parentheses: *p<0.05, **p<0.01, ***p<0.001.
Source: Author's calculations.

Table A3.8: Impact of GA (WBL index) on the gender obesity gap and the global prevalence of obesity (FE vs IV estimates), control variables added.

VARIABLES	Gender obesity gap				Prevalence of obesity (total)							
	(1) FE Linear	(2) IV Linear	(3) FE Quadratic	(4) IV Quadratic	(5) FE Interacted	(6) IV Interacted	(7) FE Linear	(8) IV Linear	(9) FE Quadratic	(10) IV Quadratic	(11) FE Interacted	(12) IV Interacted
Log (GDP)	13.064*** (2.747)	14.041*** (1.087)	8.102*** (2.343)	2.335 (6.438)	2.419*** (0.698)	2.668** (1.238)	-8.181*** (3.031)	-10.135*** (1.702)	-9.775*** (3.408)	-10.499** (4.426)	-2.001*** (0.557)	0.448 (1.124)
Log(GDP_sqr)	-0.826*** (0.166)	-0.891*** (0.065)	-0.528*** (0.149)	-0.178 (0.392)			0.401** (0.182)	0.535*** (0.099)	0.497** (0.204)	0.536** (0.270)		
Log (LE)	1.735 (2.707)	3.476** (1.407)	2.589 (2.296)	12.054*** (4.115)	1.155 (2.336)	0.856 (1.693)	-6.688*** (2.231)	-10.275*** (1.892)	-6.414*** (2.295)	-10.605*** (2.552)	-7.617*** (2.287)	-9.174*** (1.555)
WBL index	0.011 (0.013)	0.129*** (0.039)	0.300*** (0.045)	1.273*** (0.402)	0.551*** (0.092)	0.756*** (0.195)	-0.016 (0.014)	-0.234*** (0.060)	0.077 (0.048)	-0.372 (0.243)	-0.134** (0.061)	0.267 (0.173)
WBL index ²			-0.002*** (0.000)	-0.007*** (0.003)					-0.001** (0.000)	0.001 (0.002)		
WBL index * log (GDP)					-0.060*** (0.009)	-0.070*** (0.019)					0.013* (0.007)	-0.029 (0.018)
Unemployment	-0.056** (0.027)	-0.057*** (0.013)	-0.044* (0.024)	0.030 (0.031)	-0.048* (0.024)	-0.020* (0.011)	-0.023 (0.025)	-0.022* (0.013)	-0.019 (0.024)	-0.048** (0.021)	-0.033 (0.023)	-0.051*** (0.012)
Fossil fuel consumption	-0.003** (0.001)	-0.004*** (0.001)	-0.003*** (0.001)	0.000 (0.002)	-0.003** (0.001)	-0.003*** (0.001)	0.000 (0.001)	0.002** (0.001)	0.000 (0.001)	-0.004** (0.002)	0.001 (0.001)	-0.008 (0.008)
FDI	0.077*** (0.015)	0.076*** (0.006)	0.059*** (0.015)	-0.011 (0.027)	0.061*** (0.014)	0.060*** (0.013)	-0.017 (0.014)	-0.014* (0.007)	-0.022 (0.015)	-0.003 (0.017)	-0.018 (0.015)	-0.049*** (0.011)
Constant	-56.129*** (13.024)		-47.622*** (12.106)		-24.743** (10.741)		81.161*** (12.887)		83.893*** (13.127)		62.531*** (9.529)	
Observations	2,925	2,888	2,925	2,127	2,925	2,767	2,925	2,888	2,925	2,127	2,925	2,391
Number of countries	146	140	146	107	146	135	146	140	146	107	146	121
Adjusted R-squared	0.332	0.001	0.427	-1.648	0.462	0.223	0.889	0.717	0.890	0.758	0.887	0.847
F-statistic		14.78		5.47		6.31		14.78		5.47		23.48

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculations.

Table A3.9: Impact of GA (WBL index) on the prevalence of obesity among males and females (FE vs IV estimates), control variables added.

VARIABLES	Prevalence of obesity (men)						Prevalence of obesity (women)					
	(13) FE Linear	(14) IV Linear	(15) FE Quadratic	(16) IV Quadratic	(17) FE Interacted	(18) IV Interacted	(19) FE Linear	(20) IV Linear	(21) FE Quadratic	(22) IV Quadratic	(23) FE Interacted	(24) IV Interacted
Log (GDP)	-15.423*** (3.398)	-18.007*** (2.074)	-14.467*** (3.610)	-13.473* (7.394)	-3.232*** (0.644)	-4.560*** (1.394)	-2.358 (3.197)	-3.966** (1.623)	-6.365* (3.573)	-11.138*** (2.955)	-0.813 (0.658)	3.805*** (1.163)
Log(GDP_sqr)	0.860*** (0.208)	1.035*** (0.121)	0.802*** (0.220)	0.733 (0.450)			0.034 (0.188)	0.144 (0.094)	0.275 (0.214)	0.556*** (0.179)		
Log (LE)	-7.031** (2.826)	-11.810*** (2.230)	-7.195** (2.815)	-16.592*** (4.503)	-7.759*** (2.761)	-6.583*** (1.677)	-5.295** (2.288)	-8.334*** (1.929)	-4.606** (2.219)	-4.537*** (1.421)	-6.604*** (2.299)	-9.931*** (1.797)
WBLINDEX	-0.021 (0.014)	-0.317*** (0.071)	-0.077 (0.053)	-0.975** (0.437)	-0.424*** (0.083)	-0.625*** (0.216)	-0.010 (0.016)	-0.188*** (0.059)	0.223*** (0.051)	0.298*** (0.116)	0.127* (0.070)	0.868*** (0.175)
<i>WBL index</i> ²			0.000 (0.000)	0.005 (0.003)					-0.002*** (0.000)	-0.003*** (0.001)		
WBL index * log (GDP)					0.045*** (0.009)	0.063*** (0.022)					-0.015* (0.008)	-0.091*** (0.018)
Unemployment	0.007 (0.026)	0.009 (0.018)	0.005 (0.026)	-0.062* (0.036)	-0.008 (0.022)	-0.012 (0.013)	-0.049 (0.030)	-0.049*** (0.012)	-0.039 (0.028)	-0.032** (0.013)	-0.056* (0.029)	-0.081*** (0.015)
Fossil fuel consumption	0.002** (0.001)	0.005*** (0.002)	0.002** (0.001)	-0.003 (0.002)	0.002* (0.001)	0.021** (0.009)	-0.001 (0.002)	0.001 (0.001)	-0.001 (0.001)	-0.003** (0.001)	-0.001 (0.002)	-0.026** (0.011)
FDI	-0.057*** (0.014)	-0.053*** (0.009)	-0.053*** (0.015)	-0.001 (0.029)	-0.050*** (0.015)	-0.045*** (0.013)	0.021 (0.017)	0.023*** (0.007)	0.006 (0.017)	-0.012 (0.009)	0.012 (0.018)	-0.041*** (0.013)
Constant	109.524*** (14.816)		107.886*** (14.817)		73.132*** (11.044)		53.395*** (13.791)		60.265*** (13.870)		48.389*** (10.588)	
Observations	2,925	2,888	2,925	2,127	2,925	2,391	2,925	2,888	2,925	2,127	2,925	2,391
Number of countries	146	140	146	107	146	121	146	140	146	107	146	121
Adjusted R-squared	0.876	0.558	0.877	0.330	0.880	0.836	0.858	0.746	0.868	0.859	0.860	0.783
F-statistic		14.78		5.47		6.31		14.78		5.47		23.48

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculations.

Table A3.10: Impact of GA (based on PCA) on the gender obesity gap and the global prevalence of obesity (FE vs IV estimates), control variables added.

VARIABLES	Gender obesity gap						Prevalence of obesity (total)					
	(1) FE Linear	(2) IV Linear	(3) FE Quadratic	(4) IV Quadratic	(5) FE Interacted	(6) IV Interacted	(7) FE Linear	(8) IV Linear	(9) FE Quadratic	(10) IV Quadratic	(11) FE Interacted	(12) IV Interacted
Log (GDP)	12.977*** (2.606)	12.970*** (1.074)	9.871*** (2.467)	7.739 (13.528)	3.427*** (0.766)	4.908** (2.192)	-8.026*** (2.999)	-8.199*** (1.896)	-10.859*** (3.279)	-14.877** (7.314)	-2.383*** (0.707)	0.788 (1.549)
Log(GDP_sqr)	-0.814*** (0.159)	-0.789*** (0.065)	-0.611*** (0.156)	-0.242 (0.898)			0.392** (0.180)	0.350*** (0.107)	0.577*** (0.197)	0.718 (0.488)		
Log (LE)	1.865 (2.615)	3.024** (1.361)	1.480 (2.513)	11.863* (7.145)	0.291 (2.340)	-2.075 (2.532)	-6.398*** (2.241)	-9.467*** (2.113)	-6.749*** (2.248)	-11.300*** (3.669)	-6.888*** (2.263)	-9.417*** (1.792)
GA index	0.045** (0.019)	0.239*** (0.075)	0.220*** (0.063)	2.016* (1.107)	0.651*** (0.087)	0.999*** (0.306)	0.007 (0.021)	-0.433*** (0.136)	0.167*** (0.055)	-0.447 (0.590)	-0.149* (0.085)	0.286 (0.206)
<i>GA index</i> ²			-0.001*** (0.000)	-0.007 (0.007)					-0.001*** (0.000)	-0.000 (0.004)		
GA index * log (GDP)					-0.068*** (0.009)	-0.087*** (0.030)					0.017* (0.009)	-0.030 (0.022)
Unemployment	-0.058** (0.028)	-0.067*** (0.013)	-0.044* (0.026)	0.014 (0.081)	-0.043* (0.025)	-0.027** (0.012)	-0.024 (0.024)	-0.004 (0.017)	-0.011 (0.023)	-0.014 (0.045)	-0.034 (0.023)	-0.050*** (0.012)
Fossil fuel consumption	-0.003** (0.002)	-0.005*** (0.002)	-0.003*** (0.001)	-0.004 (0.008)	-0.003*** (0.001)	-0.003** (0.001)	0.000 (0.001)	0.004** (0.002)	0.000 (0.001)	0.001 (0.004)	0.000 (0.001)	-0.004 (0.006)
FDI	0.075*** (0.014)	0.066*** (0.007)	0.064*** (0.015)	-0.068 (0.074)	0.058*** (0.014)	0.043** (0.019)	-0.017 (0.014)	0.005 (0.012)	-0.027* (0.014)	0.009 (0.039)	-0.016 (0.015)	-0.051*** (0.013)
Constant	-58.640*** (12.811)		-50.466*** (12.219)		-31.305*** (10.561)		78.072*** (13.085)		85.527*** (13.344)		61.432*** (9.851)	
Observations	2,925	2,888	2,925	2,127	2,925	2,767	2,925	2,888	2,925	2,127	2,925	2,391
Number of countries	146	140	146	107	146	135	146	140	146	107	146	121
Adjusted R-squared	0.347	-0.033	0.390	-11.270	0.472	0.188	0.888	0.585	0.894	0.430	0.887	0.849
F-statistic		7.94		2.12		3.34		7.94		2.12		14.21

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculations.

Table A3.11: Impact of GA (based on PCA) on the prevalence of obesity among males and females (FE vs IV estimates), control variables added.

VARIABLES	Prevalence of obesity (men)						Prevalence of obesity (women)					
	(13) FE Linear	(14) IV Linear	(15) FE Quadratic	(16) IV Quadratic	(17) FE Interacted	(18) IV Interacted	(19) FE Linear	(20) IV Linear	(21) FE Quadratic	(22) IV Quadratic	(23) FE Interacted	(24) IV Interacted
Log (GDP)	-15.228*** (3.370)	-15.382*** (2.324)	-16.402*** (3.642)	-21.226 (13.898)	-4.119*** (0.808)	-7.023*** (2.100)	-2.251 (3.109)	-2.412 (1.775)	-6.531* (3.337)	-13.487*** (3.197)	-0.692 (0.779)	6.175*** (1.597)
Log(GDP_sqr)	0.845*** (0.206)	0.785*** (0.132)	0.921*** (0.221)	0.994 (0.927)			0.030 (0.184)	-0.004 (0.099)	0.311 (0.201)	0.752*** (0.202)		
Log (LE)	-6.818** (2.881)	-10.713*** (2.516)	-6.963** (2.884)	-17.419** (7.153)	-6.617** (2.782)	-4.126** (2.080)	-4.953** (2.201)	-7.689*** (2.102)	-5.483** (2.155)	-5.556*** (1.507)	-6.326*** (2.242)	-12.111*** (2.109)
GA index	-0.016 (0.022)	-0.586*** (0.163)	0.050 (0.066)	-1.362 (1.137)	-0.489*** (0.096)	-0.868*** (0.285)	0.029 (0.023)	-0.348*** (0.129)	0.270*** (0.059)	0.655*** (0.185)	0.162* (0.093)	1.081*** (0.204)
<i>GA index</i> ²			-0.001 (0.000)	0.002 (0.007)					-0.002*** (0.000)	-0.005*** (0.001)		
GA index * log (GDP)					0.053*** (0.011)	0.087*** (0.029)					-0.015 (0.010)	-0.112*** (0.022)
Unemployment	0.008 (0.026)	0.033 (0.021)	0.013 (0.026)	-0.012 (0.085)	-0.012 (0.023)	-0.009 (0.014)	-0.050* (0.030)	-0.034** (0.016)	-0.031 (0.028)	0.002 (0.017)	-0.055* (0.029)	-0.081*** (0.015)
Fossil fuel consumption	0.002** (0.001)	0.008*** (0.003)	0.002** (0.001)	0.004 (0.008)	0.002 (0.001)	0.016** (0.007)	-0.001 (0.002)	0.002 (0.002)	-0.001 (0.001)	0.001 (0.002)	-0.001 (0.002)	-0.019** (0.009)
FDI	-0.056*** (0.014)	-0.027** (0.014)	-0.060*** (0.015)	0.036 (0.075)	-0.047*** (0.016)	-0.030* (0.017)	0.019 (0.017)	0.039*** (0.011)	0.004 (0.017)	-0.032** (0.013)	0.011 (0.018)	-0.054*** (0.014)
Constant	107.840*** (14.901)		110.929*** (15.039)		75.479*** (10.411)		49.199*** (13.948)		60.463*** (14.054)		44.175*** (11.683)	
Observations	2,925	2,888	2,925	2,127	2,925	2,391	2,925	2,888	2,925	2,127	2,925	2,391
Number of countries	146	140	146	107	146	121	146	140	146	107	146	121
Adjusted R-squared	0.875	0.361	0.876	-1.324	0.881	0.832	0.859	0.643	0.872	0.860	0.861	0.781
F-statistic		7.94		2.12		14.21		7.94		2.12		14.21

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculations.

Table A3.12: Descriptive statistics (means): obesity outcomes, GA indexes and GDP by country during the period.

	Global obesity rates (%)	Male obesity rates (%)	Female obesity rates (%)	Obesity gender gap (%)	WBL index (100-point score)	PCA-based index (100-point score)	GDP (constant \$, PPP, 2017)
Afghanistan	2.95556	1.49259	4.27407	2.78148	26.85185	7.64545	1739.408
Albania	14.97778	13.25926	16.18148	2.92222	76.80556	77.95912	7523.683
Algeria	19.35556	11.77037	26.30741	14.53704	47.19907	34.89004	9766.4796
Angola	4.58889	1.82593	6.97037	5.14444	61.25	55.92225	6038.1807
Argentina	22.20741	20.2037	23.45926	3.25556	67.12963	69.33926	19789.163
Armenia	15.32593	11.7963	18.05185	6.25556	66.13426	76.2818	6552.8766
Australia	21.91111	21.23704	21.98889	.75185	81.94444	83.62941	39859.774
Austria	15.14815	15.35926	14.41111	-.94815	81.99074	85.88472	47029.512
Azerbaijan	14.07037	10.04815	17.25926	7.21111	68.98148	79.27328	8282.2512
Bahamas	25.24815	17.02593	32.18148	15.15556	76.36574	82.7993	35041.997
Bahrain	24.08889	18.63333	31.87407	13.24074	29.79167	30.17716	45406.078
Bangladesh	1.78519	.96296	2.61852	1.65556	41.27315	39.28568	2739.2045
Barbados	16.74815	9.06296	23.59630	14.53333	70.34722	80.86076	15146.947
Belarus	19.91852	15.41481	23.14444	7.72963	69.83796	82.13249	11800.249
Belgium	17.95556	17.21852	18.16296	.94444	79.25926	82.0318	43571.896
Belize	17.88148	10.67407	24.60741	13.93333	72.70833	63.62055	8604.6916
Benin	5.93704	2.45185	8.87407	6.42222	55.13889	51.91109	2480.5009
Bhutan	3.28519	2.05185	4.61852	2.56667	59.09722	61.38608	5630.9955
Bolivia	14.52222	9.07778	19.20741	10.12963	61.8287	61.92007	5799.5777
Bosnia and Herzegovina	13.60741	11.68889	14.88148	3.19259	69.65278	73.37081	8285.318
Botswana	13.9963	4.43704	22.39259	17.95556	45.94907	56.42898	11861.903
Brazil	15.96667	12.01481	19.17407	7.15926	66.94444	70.21965	12612.411
Brunei	8.58889	6.45556	10.47407	4.01852	46.22685	55.90127	68591.435
Bulgaria	19.85926	18.32963	20.72222	2.39259	77.84722	85.57378	14437.205
Burkina Faso	2.87778	1.12222	4.22593	3.1037	71.36574	59.25579	1405.7647
Burundi	3.01481	1.04074	4.78519	3.74444	63.93519	58.11813	892.29575
Cambodia	1.98519	1.17037	2.57037	1.4	63.95833	69.27083	2167.4191
Cameroon	6.98148	3.15926	10.44815	7.28889	50.06944	52.01232	3156.5371
Canada	22.15185	21.14444	22.52593	1.38148	97.10648	95.14937	43918.554
Cape Verde	7.38889	3.44815	10.40370	6.95556	72.19907	67.5854	4163.8631
Central African Republic	4.64074	1.96667	6.92593	4.95926	60.81019	53.63168	1020.985
Chad	3.58889	1.60741	5.32963	3.72222	54.90741	44.39277	1324.6533
Chile	22.04444	18.1963	25.18519	6.98889	64.72222	66.30327	17457.477
China	3.15926	2.45556	3.70370	1.24815	66.25	75.79705	5730.8856
Colombia	16.6963	11.62222	20.85556	9.23333	66.78241	69.4736	10600.676
Comoros	4.88148	1.86296	7.65926	5.7963	45.46296	42.84689	2896.493
Congo	6.08148	2.86296	8.98148	6.11852	49.375	56.07835	4666.9631
Costa Rica	17.0963	12.18889	21.43704	9.24815	75.50926	70.1046	14062.675
Croatia	18.90741	16.88519	20.11111	3.22593	74.18981	81.11775	22123.494
Cyprus	17.35556	15.86296	18.33704	2.47407	80.83333	81.35295	33162.059
Czechia	21.98519	20.40741	22.94815	2.54074	77.80093	83.029	28312.211
Côte d'Ivoire	6.07778	2.92222	9.60000	6.67778	64.83796	51.72966	3834.3834
Congo	3.84444	1.71852	5.68148	3.96296	.	.	942.85538
Denmark	15.12963	15.83333	13.91481	-1.91852	89.53704	90.4642	48096.497
Dominican Republic	18.51481	11.74074	24.74444	13.0037	75.34722	68.00929	10194.565
Ecuador	14.47778	9.59259	18.85926	9.26667	74.65278	70.10705	9520.5025
Egypt	24.19259	14.86296	32.67778	17.81481	35.78704	32.44654	7958.5924
El Salvador	17.29259	11.73333	21.40741	9.67407	74.00463	70.73455	6805.0006
Equatorial Guinea	4.96667	2.02963	8.07037	6.04074	46.66667	45.88209	17528.51
Eritrea	2.81852	1.01111	4.28519	3.27407	66.13426	62.03334	.
Estonia	18.17778	15.18519	20.11111	4.92593	73.56481	83.68428	23829.331
Eswatini	11.88519	2.98148	19.27407	16.29259	39.49074	51.24964	6179.4376
Ethiopia	2.45556	.93704	3.86296	2.92593	58.40278	52.05827	973.60613
Fiji	22.63333	16.67778	28.01481	11.33704	60.37037	56.99491	9653.9998
Finland	17.38889	17.25556	16.87778	-.37778	88.81944	90.7917	40272.743
France	16.92963	15.79259	17.52963	1.73704	89.76852	89.73178	39545.45
Gabon	10.35556	5.41111	14.71852	9.30741	50	49.68451	15835.5
Gambia	5.91852	2.6963	9.07037	6.37407	61.64352	52.84779	2015.6448
Georgia	15.38889	12.34815	17.48148	5.13333	65.06944	75.93948	7562.3559
Germany	17.41111	17.51852	16.64444	-.87407	82.24537	86.22018	44043.044
Ghana	6.62593	2.27407	10.56296	8.28889	64.76852	65.26686	3205.3962
Greece	19.74074	17.18148	21.65556	4.47407	79.14352	80.44576	29618.054
Guatemala	14.57778	9.17407	19.10000	9.92593	63.7037	54.14571	6762.0809
Guinea	4.52963	1.87407	6.92963	5.05556	47.98611	52.02669	1758.9667
Guinea-Bissau	5.36296	2.33333	8.05556	5.72222	40.18519	44.86564	1796.9085
Guyana	13.68889	7.29259	19.45185	12.15926	80.02315	69.66947	8318.854
Haiti	13.46296	8.73704	17.21852	8.48148	61.25	63.03822	3042.2802
Honduras	14.37037	9.20741	18.98148	9.77407	63.93519	56.27893	4388.325
Hungary	21.02222	20.47407	20.89630	.42222	77.87037	83.90015	21739.677
Iceland	17.13704	17.40741	16.35185	-1.05556	91.36574	90.21649	45658.852

India	2.08889	1.24444	2.87407	1.62963	61.25	50.54856	3214.7447
Indonesia	3.47037	1.89259	4.82963	2.93704	55.81019	59.89824	6884.4826
Iran	18.38148	11.67037	24.75556	13.08519	27.40741	26.60645	12424.614
Iraq	23.85185	16.21481	30.68148	14.46667	33.125	17.14474	7009.373
Ireland	17.81852	16.77778	18.25556	1.47778	88.7963	84.90968	47891.713
Israel	22	19.74074	23.61111	3.87037	73.54167	74.40016	31883.953
Italy	15.94815	14.80741	16.54815	1.74074	80.83333	81.51225	41302.66
Jamaica	17.6963	8.97778	25.60000	16.62222	59.88426	69.69131	9777.7446
Japan	2.58519	2.4037	2.58889	.18519	78.03241	80.96705	36921.836
Jordan	27.94815	19.6	36.18889	16.58889	27.68519	21.85348	9814.4146
Kazakhstan	15.38889	12.7037	17.10370	4.4	65.09259	75.76627	15564.235
Kenya	4.04444	1.40741	6.45185	5.04444	59.3287	60.99764	3570.5091
Kuwait	31.35926	25.41111	40.68148	15.27037	26.94444	34.28952	61015.066
Kyrgyzstan	11.07407	8.62963	12.83704	4.20741	65.90278	69.17816	3751.4317
Laos	2.48148	1.35185	3.35926	2.00741	68.14815	69.59018	3649.6348
Latvia	20.17037	15.97407	23.13333	7.15926	78.65741	87.17373	19011.164
Lebanon	25.74815	19.71111	31.34444	11.63333	47.80093	44.69121	14122.394
Lesotho	11.28148	2.22963	18.40000	16.17037	53.75	60.87661	1942.4705
Liberia	6.56667	3.15926	9.62222	6.46296	66.25	60.88021	1467.1567
Libya	25.32222	17.45185	33.34074	15.88889	41.25	44.75713	26854.411
Lithuania	22.53704	18.18148	25.57407	7.39259	79.00463	87.1355	20939.18
Luxembourg	17.17407	17.14815	16.63704	-.51111	87.43056	85.18908	99749.077
Madagascar	2.91852	1.42963	4.22963	2.8	55.39352	56.74687	1546.9574
Malawi	3.2963	1.13333	5.24074	4.10741	55.39352	55.66356	1157.0036
Malaysia	8.83704	6.13704	11.09259	4.95556	46.78241	53.02332	17431.73
Maldives	4.21111	2.25556	6.07778	3.82222	49.83796	47.52213	15029.812
Mali	4.84074	2.11111	7.13704	5.02593	48.10185	41.17392	1749.9464
Malta	24.21852	22.29259	25.51111	3.21852	66.71296	66.08335	27321.565
Mauritania	7.92222	3.3963	11.92222	8.52593	40.25463	32.87926	4628.7275
Mauritius	7.59259	3.58519	11.18519	7.6	72.80093	70.70967	13861.272
Mexico	22.33704	17.2	26.38519	9.18519	72.61574	66.94409	17514.037
Mongolia	13.58519	10.12222	16.32593	6.2037	69.62963	74.91581	6275.9984
Montenegro	17.48889	15.66667	18.58148	2.91481	66.59722	75.21342	15207.949
Morocco	18.52222	11.7963	24.14074	12.34444	55.6713	48.33632	4975.6363
Mozambique	4.35926	1.73704	6.44815	4.71111	52.89352	56.99528	797.97851
Myanmar	2.94074	1.68148	3.93704	2.25556	54.30556	62.2913	1769.1053
Namibia	11.14444	3.56667	17.40000	13.83333	68.19444	68.30255	7884.9425
Nepal	2.1	1.2	2.84815	1.64815	45.34722	58.32826	2251.2642
Netherlands	14.53333	13.30741	15.12593	1.81852	89.23611	88.3744	46860.461
New Zealand	23.33333	21.58148	24.43704	2.85556	87.87037	87.63714	34439.288
Nicaragua	17.17037	11.57407	21.99630	10.42222	65.94907	59.92994	4188.6429
Niger	3.14074	1.22963	5.00000	3.77037	50.18519	39.30763	1000.7885
Nigeria	4.9963	2.16667	7.61852	5.45185	56.13426	52.18582	3878.9517
Norway	17.32963	16.21111	17.84815	1.63704	90.78704	90.89048	56677.707
Oman	19.34815	14.43704	26.15185	11.71481	32.03704	22.65653	36048.35
Pakistan	4.88889	2.97037	6.73704	3.76667	39.79167	23.57635	3712.4287
Panama	16.21852	11.29259	20.69630	9.4037	68.49537	65.51068	17742.477
Papua New Guinea	14.8963	10.49259	18.74815	8.25556	57.68519	60.89725	3281.8491
Paraguay	13.9037	10.67778	16.69259	6.01481	82.91667	73.01607	10020.951
Peru	14.77407	10.11852	18.93704	8.81852	80.55556	77.22386	7890.5363
Philippines	3.8963	2.72222	4.82222	2.1	69.56019	64.27237	5140.6714
Poland	18.64815	17.12222	19.33333	2.21111	69.07407	78.57646	18400.504
Portugal	15.07778	13.15926	16.27778	3.11852	83.58796	88.06137	29174.052
Qatar	27.73704	23.66296	37.26296	13.6	29.14352	24.707	94717.959
Republic of Korea	3.2	2.55185	3.60370	1.05185	70.39352	75.89804	26372.757
Republic of Moldova	15.14444	11.10741	18.17037	7.06296	68.24074	80.83599	7408.5974
Russia	19.88889	12.89259	25.08519	12.19259	69.23611	81.2615	19536.539
Rwanda	3.04074	.83333	4.94074	4.10741	57.15278	59.54713	1140.8928
Samoa	38.7	29.78148	47.10741	17.32593	57.5	49.99084	4769.9849
Sao Tome and Principe	7.52593	3.60741	10.73333	7.12593	55.09259	46.16736	3184.0296
Saudi Arabia	27.56296	21.54074	35.49259	13.95185	25.43981	17.18079	42805.177
Senegal	5.54074	2.16667	8.36296	6.1963	60.39352	48.17719	2664.34
Sierra Leone	5.3	1.97778	8.35926	6.38148	41.875	47.654	1308.2182
Singapore	4.76667	3.79259	5.52963	1.73704	69.18981	74.25003	62803.068
Slovakia	16.45556	15.28148	17.02963	1.74815	73.35648	81.09232	19992.613
Solomon Islands	15.28889	10.71852	19.52222	8.8037	54.46759	57.5772	2361.6727
Somalia	4.97037	2.04074	7.58148	5.54074	46.875	28.2275	980.16032
South Africa	21.37778	8.77037	31.97407	23.2037	69.14352	72.1649	11750.937
Spain	19.32593	18.24444	19.73333	1.48889	90.39352	88.46361	34274.204
Sri Lanka	2.74815	1.25926	4.08519	2.82593	62.43056	61.83036	7413.2999
St. Lucia	14.08148	7.45556	20.07407	12.61852	74.79167	77.57003	13246.152
St. Vincent and the Grenadines	16.43704	9.63704	22.78519	13.14815	65.30093	67.2142	9880.1558
Suriname	20.38889	12.71852	27.40370	14.68519	64.28241	63.01394	15404.373
Sweden	15.72963	16.27037	14.64444	-1.62593	91.71296	92.16267	42114.4
Switzerland	14.84444	15.67778	13.49259	-2.18519	77.40741	83.0673	61263.443
Syria	20.08148	13.05185	26.76296	13.71111	31.13426	23.93454	.

Tajikistan	9.31481	7.02593	11.21852	4.19259	67.4537	59.59424	2117.2534
Thailand	5.05926	2.80741	6.92593	4.11852	62.89352	74.25299	11700.879
Yugoslavia	18.01852	16.54815	18.98519	2.43704	72.63889	74.74766	11474.386
Togo	4.98519	1.94444	7.57037	5.62593	59.23611	57.94151	1656.7496
Tonga	39.14074	30.62963	46.42593	15.7963	51.34259	51.30144	4871.1415
Trinidad and Tobago	12.17778	6.2	17.54444	11.34444	67.98611	72.54558	20145.192
Tunisia	19.83704	11.96296	27.01111	15.04815	58.1713	52.92058	8376.687
Turkey	24.06667	15.75556	31.05556	15.3	62.5463	56.93367	17472.444
Uganda	2.98148	.91111	4.90741	3.9963	54.97685	50.46741	1471.1852
Ukraine	20.09259	15.82593	23.12963	7.3037	68.26389	82.44502	10930.037
United Arab Emirates	23.98148	19.24074	34.47037	15.22963	23.40278	20.99932	84890.133
UK	20.47407	18.5037	21.82963	3.32593	86.8287	87.76804	39289.439
Tanzania	4.75185	1.92593	7.29259	5.36667	71.11111	65.4951	1653.2856
USA	27.5	25.46296	28.72963	3.26667	83.28704	85.08648	50356.336
Uruguay	22.0037	18.04074	25.03704	6.9963	71.89815	75.46649	15982.333
Uzbekistan	11.16667	8.5963	13.16667	4.57037	63.26389	66.38881	3957.3304
Vanuatu	17.52222	12.62222	22.12963	9.50741	56.27315	56.90943	2855.9186
Venezuela	20.55185	16.4963	24.05185	7.55556	71.78241	69.2612	.
Viet Nam	.95556	.56296	1.23704	.67407	64.60648	75.71251	4705.2215
Yemen	10.53333	6.1963	14.40000	8.2037	24.67593	9.88464	.
Zambia	5.06296	1.94444	7.96296	6.01852	60.30093	57.53907	2531.705
Zimbabwe	11.47778	2.71852	19.30370	16.58519	74.16667	74.61999	2325.0653

Source: Author's calculations.

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General Conclusion

Since the Fourth World Conference on Women (Beijing, 1995), development actors have consistently integrated a gender dimension into policies and programs, aligning with the global goal of promoting gender equality and women's empowerment. In this thesis, we propose adopting this gender-focused approach to explore the intricate relationship between socio-economic inequalities and malnutrition. This approach is crucial because malnutrition is deeply rooted in socio-economic and gender disparities, disproportionately affecting the most disadvantaged individuals, particularly women, during critical pregnancy and lactation periods. Unfortunately, malnutrition can also perpetuate these socio-economic and gender inequalities over time. As a result, this thesis advocates that policies aimed at the fight against malnutrition, in all its forms, cannot be considered without putting women at the heart of these questions. Additionally, we emphasize the need for a comprehensive understanding of the concept of women's empowerment, considering it from diverse perspectives. This holistic comprehension is essential for effective interventions, laying the groundwork for achieving the desired outcomes in nutrition and socio-economic equality efforts.

Through three chapters that offer unique insights into specific malnutrition issues, this thesis provides a general overview of the nutrition transition process outlined by Popkin (1999). Chapter 1 delves into the decline in undernutrition problems such as stunted growth and low dietary diversity. Chapter 2 addresses shifts in eating behaviors, particularly suboptimal breastfeeding practices, while Chapter 3 examines the rise in overnutrition issues, specifically obesity. What sets this thesis apart is its integration of a gender perspective into the nutrition transition process. This approach proves relevant as it examines the intricate interplay between socio-cultural shifts, global economic changes and rising incomes among populations. By examining these factors, the thesis sheds light on the complex dynamics of nutrition in developing societies. It unravels how gender elements intersect with malnutrition patterns, providing deep insights into changing socio-economic health inequalities through a gender lens. Understanding these dynamics is crucial to understanding evolving health inequalities through a gendered framework. The following sections will be devoted to succinctly summarising the key findings from each chapter, highlighting their contributions, discussing their implications and suggesting avenues for further research and improvement.

Chapter 1 deals with the persistent issue of child undernutrition in Nepal despite ongoing poverty reduction efforts. International organizations are now advocating a novel strategy that centers on empowering women and reducing gender inequality. In our study, we take a unique approach to examine how both women's socio-economic status (SES) and their empowerment (WE) - considering a range of power dimensions - impact child nutrition. Using data from the 2016 Nepal Demographic and Health Survey, we stress the necessity for a holistic perspective on women's empowerment, going beyond a singular focus on SES. Indeed, our results support that it is essential to recognize that non-economic facets of women's empowerment wield significant influence over children's nutrition, helping alleviate the detrimental effects of low mother's SES and narrowing gender disparities, with a particularly positive impact on girls. In addition, while we recognize the importance of maternal SES, particularly in rural areas where we emphasize the need to promote women's education, we advocate a cautious approach to the health consequences of their participation in the labor force. In particular, we underline that while women's participation in agricultural production may enhance children's dietary diversity, it also can be negatively correlated with children's height-for-age. This contradiction demands further research, particularly within the context of the "feminization of agriculture." In this regard, studies such as those by Pattnaik et al. (2018) and Ruel et al. (2018) underscore how agricultural work, coupled with domestic and childcare responsibilities, compromises women's well-being, subsequently affecting child nutrition through maternal health (Rao et al., 2019). On a broader scale, we highlight the ambiguity surrounding definitions and measurements of women's empowerment, which remains a challenge. Some perceive it merely as a means to attain other development objectives, such as agricultural productivity and economic growth (*i.e.*, Buisson et al., 2022). Others view it as a diluted version of its original feminist intent, a notion put forth by scholars like Batliwala (2007), Cornwall (2016), and Mukhopadhyay (2016). To address this ambiguity, we advocate for research that views women's empowerment as an end in itself rather than a means to other ends. In practice, even with theoretically high levels of women's empowerment, they may not fully harness these opportunities due to feelings of inadequacy tied to family needs or personal experiences (O'Hara & Clement, 2018). In this regard, conducting qualitative interviews with mothers can provide valuable insights into understanding local barriers that contribute to malnutrition in women's daily lives. For example, O'Hara & Clement (2018) emphasize the importance of household composition, such as living with the husband's family or the presence/absence of one or more men due to migration, which plays a crucial role in the context of women's empowerment in Nepal. Finally, understanding the dynamics between men and women in

empowerment initiatives is of utmost importance. Studies indicate that men can either cooperate and embrace new roles (Schuler et al., 2013) or respond with violence (Kelly-Hanku et al., 2016), highlighting the need for well-balanced empowerment strategies to achieve the desired outcomes. We caution against overlooking contextual gender norms, which, if misaligned with development actors' perspectives, can intensify gender conflicts and disrupt empowerment pathways (Vercillo, 2020). In summary, our research underscores the imperative of adopting a comprehensive and nuanced approach, taking into account various dimensions and contextual factors to empower women and fight against child undernutrition in Nepal.

Chapter 2 examines Asia's changing landscape, exploring the relationship between household wealth and optimal breastfeeding (BF) practices in a local context of economic growth and increased female labor force participation. The study assesses how this relationship evolves with economic development. Using data from 42 Demographic Health Surveys across 15 Asian countries (1990-2017), our findings reveal shifting patterns: breastfeeding practices are pro-poor in the poorest nations, but the negative association with wealth decreases as economic development progresses. Exclusive breastfeeding and continued breastfeeding show significant changes (towards pro-rich practices), while early initiation remains pro-poor, albeit higher in wealthier countries. Our research makes crucial contributions in several respects. First, our study offers crucial general insights into the dynamics of BF practices in Asia, a region contributing significantly to the 37% global economic losses caused by suboptimal breastfeeding practices (Walters et al., 2019). In particular, these findings hold significant importance in the context of concerns about middle-income countries in East Asia, such as China, Indonesia, Malaysia, Thailand, and Vietnam, where high infant formula sales have been recorded (Baker et al., 2016). Second, this study addresses a gap in the existing literature by exploring the complex interplay between macro and micro-level factors shaping BF practices, testing the reversal hypothesis already demonstrated in other non-communicable diseases studies (Dinsa et al., 2012; Pampel et al., 2012; Zhang et al., 2023), but not explored in BF research. Last but not least, our study pioneers in addressing endogeneity issues and offering valuable econometric insights, surpassing limited evidence of descriptive statistics. Obviously, this research presents certain limitations that offer room for improvement and future research. First, our estimates lack crucial control variables related to supply-side factors, particularly the dynamics of the local infant formula market. This remark is relevant considering the intensified marketing efforts of milk formula companies in low-middle-income countries (Hawkes, 2005, 2006; Rollins et al., 2023a), promoting breast milk substitutes (BMS) as superior to breast milk.

Second, the absence of high-income Asian nations in our study, like Japan, South Korea, Singapore, and Taiwan, restricts a comprehensive understanding of breastfeeding practice reversal, highlighting the need for further research in these contexts. Despite these limitations, our research holds significant policy implications, emphasizing the urgent need for specific measures to protect breastfeeding practices, particularly among economically disadvantaged communities. Broadly, breastfeeding places considerable demands on women's time and competes with their income-earning activities (Smith, 2004). Several studies underline that most mothers can and choose to breastfeed but cannot do this as long as they want (*e.g.*, Hamner et al., 2021; Odom et al., 2013; Perrine et al., 2012). Public policies must, therefore, alleviate women's work burdens (*e.g.*, England & Folbre, 1999; Folbre, 1983), addressing issues such as job insecurity and inadequate maternity protection, which often force mothers, especially in low-middle-income countries and among the poorest, to resort to BMS (Baker et al., 2023). To counter this, policy implementations such as labor reforms, social safety nets, maternity leave, and cash transfers are vital. Additionally, it is crucial to fund accessible public services like baby-friendly hospitals and community-based peer counseling, as many communities lack the necessary economic and educational resources to support breastfeeding effectively (*e.g.*, Balogun et al., 2017; Bhan et al., 2020). Moreover, investing in infrastructure such as electricity, water, and transport can assist women in managing their time efficiently amidst multiple demands (*e.g.*, Agénor & Agénor, 2014). Finally, our study aligns with conclusions from the Lancet's reports' (Baker et al., 2023; Pérez-Escamilla et al., 2023; Rollins et al., 2023b), emphasizing that breastfeeding cannot be solely the responsibility of women. Collective societal approaches are necessary, addressing gender inequities and providing support to mothers and families so they can continue breastfeeding while participating in other aspects of life, such as education and employment (Gutierrez-de-Terán-Moreno et al., 2022). This approach is crucial for adapting to changing breastfeeding patterns, historically essential in reducing socio-economic health gaps and preventing adult non-communicable diseases (*e.g.*, Horta et al., 2023; Stoodly et al., 2019).

Chapter 3 focuses on the rising obesity issues in the context of global economic development and reduced gender inequalities. In this research, we investigate how evolving gender-role attitudes influence the gender obesity gap and overall obesity rates, analyzing the interplay between progressive/feminist values and obesity trends. To do so, we use an extensive panel database of 4536 observations across 168 countries from 1990 to 2016, combining obesity prevalence data from the WHO with gender attitudes information from the World Bank. Our

findings demonstrate that high levels of gender-egalitarian attitudes correlate with a slight decline in obesity prevalence among women, juxtaposed with an upward trend among men. This result indicates a shift in the burden of obesity from women and traditional gender roles (referred to as "the weight of patriarchy") (*i.e.*, Costa-Font & Györi, 2020) to men and modern society (as "the weight of modernity"). In essence, obesity gaps are narrowing worldwide in the context of a general rise in obesity rates. Among our main contributions, this study extends prior research, which primarily focused on the relationship between women's excess in obesity rates, gender disparities, and traditional gender roles (*e.g.*, Garawi et al., 2014; He & Xie, 2022; Wells et al., 2012). Instead, this research delves into the intricate ways evolving gender attitudes also influence obesity rates in both men and women, emphasizing the crucial roles of cultural and social factors. From this point of view, we can provide more elements of explanation for the reversal of the SES-obesity gradient among women in high-income countries, not observed among men (McLaren, 2007; Sobal & Stunkard, 1989). Besides, the study also grapples with the challenge of measuring cultural shifts in gender attitudes, adopting a holistic global perspective that encompasses various aspects of women's empowerment, including legal, demographic, and economic changes. However, the research has its limitations. First, we indirectly consider the influence of religious factors through gender attitudes, although we acknowledge that diverse religious groups do not respond similarly to secular societies (*i.e.*, Wilson, 2016). Second, we call for further research to explore the micro-economic mechanisms behind the increasing obesity prevalence in men during the period of "gender convergence" in obesity (Ameye & Swinnen, 2019). According to the literature, understanding health inequalities between women and men requires a comprehensive understanding of the interplay between the sources of biological and social factors (Bird & Rieker, 1999). Building on our findings and the existing literature, we can offer insights into the mechanisms at play, although these require further exploration. Regarding women, the literature highlights a higher biological predisposition to obesity compared to men due to factors such as adipose tissue distribution (*e.g.*, Karastergiou et al., 2012; Power & Schulkin, 2008). Social roles and gender inequalities exacerbate this risk (Garawi et al., 2014; He & Xie, 2022; Wells et al., 2012), with women often experiencing significant levels of inequality and deprivation (Dhar et al., 2019; Jayachandran, 2015). According to our findings, changing attitudes towards gender roles influence the "social" aspect of women's obesity risk in a U-shaped relationship. For low- and middle-income countries, we can imagine that the growing market for packaged foods (Popkin & Ng, 2022) combined with compensation for past food deprivation during childhood (Olson et al., 2007) may first contribute to an increase in excess of obesity among women, torn between the burden

of "traditional" and "modern" societies. Differently, wealthier countries witness women focusing more on healthy eating and physical activity (Fagerli & Wandel, 1999; Wardle et al., 2004), while men face eroding biological advantages due to economic and social changes. Indeed, the existing literature suggests that men tend to be less concerned about their weight (Kim & Shin, 2020) and consume foods and beverages that contribute to obesity, such as alcoholic beverages (Castetbon et al., 2009). The literature also underscores that unemployment in high-income countries disproportionately affects men (Montgomery et al., 1998), leading to unhealthy behaviors and contributing to the obesity trend (Emerson, 2011; Kakinaka & Miyamoto, 2012). Hence, this nuanced exploration of the interplay between biological factors, changing gender roles and socio-economic dynamics provides a foundation for future research. By delving deeper into these complexities, researchers can gain a more comprehensive understanding of the mechanisms driving obesity trends between men and women, enabling the development of targeted interventions to address these disparities effectively.

In summary, this work serves as an introduction to the myriad of research questions that may arise within the overarching theme of socio-economic inequalities, gender and malnutrition. Overall, deep gender inequalities undeniably contribute to an increased risk of malnutrition in the population. To illustrate this, Marphatia et al. (2016) highlight that, independent of GDP, gender inequality explains a significant proportion of the variance in low birth weight, child malnutrition and child mortality in 96 countries. According to Osmani & Sen (2003), this gender discrimination is concerning because it not only harms women but also imposes a high economic cost on society by affecting the health of everyone, including men. On the one hand, women's disadvantages in health, nutrition, and other aspects of their lives lead to a resurgence of diseases (such as infectious communicable diseases) among the less affluent, primarily through child malnutrition. It also contributes to female mortality, commonly referred to as the "missing women" phenomenon (*i.e.*, Sen, 1989). On the other hand, it is important to note that women's lack of access to resources and opportunities, as highlighted by Osmani & Sen (2003), does not only impact women themselves but can also have far-reaching consequences for society as a whole. The previous conclusion is evident in the "Barker hypothesis" (Barker et al., 2005), which suggests that the health of an entire society, since everyone is "born of a woman," is influenced by the conditions and nutrition of mothers during pregnancy. These conditions can play a role in the broader shift towards "epidemiological transition" (*i.e.*, Omran, 2001), where societies face a growing burden of chronic and non-communicable diseases associated with overnutrition. As a result, addressing gender inequalities appears to be a

promising approach to mitigating malnutrition problems. However, this conclusion raises another important question: how can we effectively implement the reduction of gender inequalities to achieve the desired nutritional and health outcomes? In my view, this is the central starting point for further research on this topic. While these policies are necessary, they may also have negative externalities that need to be anticipated and managed rather than replacing one problem with another. In this way, I would like to conclude this thesis by briefly paving the way for other research perspectives that are potentially interesting for the future.

An intriguing area of research, for instance, could center around the evolving mother-child dyad relationship in the 21st century, as evidenced by Mackey & Immerman (2009), and its impact on individuals' health. Precisely, the authors suggest that this model has become the predominant family structure in modern societies characterized by increased divorce rates and non-marital births. This new model contrasts with the traditional nuclear family, which comprises a father, mother, and children. In this context, one key concern pertains to the potential implications of such family structures on child nutrition and health. For instance, a study conducted by Ayllón & Ferreira-Batista in 2015 in Brazil revealed that children raised by single mothers exhibit lower height-for-age z-scores compared to children with similar characteristics who live with both parents. Consequently, the shift away from a preference for sons, often associated with the promotion of greater gender equality values, may also result in children growing up without a father (*e.g.*, Ananat & Michaels, 2008; Dahl & Moretti, 2008), leading to poorer outcomes. Besides, the literature consistently demonstrates a positive relationship between the duration and intensity of a mother's work and an increase in children's body mass index (*e.g.*, Benson & Mokhtari, 2011; Coley & Lombardi, 2012; Scholder, 2007). Several mechanisms may explain these adverse outcomes, including the trade-off between domestic, formal work time and leisure time (Leibowitz, 2005), reduced meal preparation at home (Crepinsek et al., 2004), and the consumption of pre-prepared meals with lower nutritional content (French et al., 2001). However, the composition of the family structure emerges as a significant factor moderating the negative impact of maternal employment, particularly in non-standard work arrangements (Li et al., 2014), with single-parent families potentially being the most vulnerable (*e.g.*, Dockery et al., 2009; Han & Waldfogel, 2007). Given these considerations, it appears attractive to conduct further research into the complex and multifaceted interplay of gender dynamics, particularly how the evolving relationship between men and women during processes of economic and social development impacts malnutrition and health issues.

Turning to another topic and building on our previous work, it would be interesting to explore the forms of women's empowerment that should be promoted to achieve better nutritional outcomes. For instance, we can focus on the "feminist problem of breastfeeding" mentioned by McCarter-Spaulding (2008). In this regard, several authors, such as Lorber & Moore (2002), Ratcliff (2002) and Wallace & Chason (2007), point to that infant feeding in the modern world is associated with a process of medicalization of pregnancy and reproduction (*e.g.*, Cesareans, epidurals, hospital deliveries), largely unfavorable to optimal breastfeeding practices (*e.g.*, Dewey, 2001; DiMatteo et al., 1996). This medicalized environment may be seen as progress in supporting women during childbirth while simultaneously introducing bottle-feeding as a means to free women from the opportunity cost of balancing their professional career goals with maternity. Conversely, some women advocate for physiological, so-called natural childbirth, promoted as a counter-power to medicalized childbirth with epidurals, itself risking becoming a space of domination in care relationships (Guilloux, 2021). According to our findings in Chapter 2, maternal breastfeeding practices are becoming increasingly elitist (at least in Asia). The most affluent women appear to be moving away from endorsing contemporary reproductive norms to favoring traditional values that promote maternal breastfeeding practices. However, we acknowledge, thanks to the literature, the challenges of combining a natural diet with work outside the home due to our social structure (*e.g.*, Galtry, 1997; Roe et al., 1999). That is why, on the opposite, the duration of maternity leave and the time before returning to work are significantly correlated with the duration of breastfeeding (Bagwell et al., 1992; Roe et al., 1999). Consequently, we can hypothesize that this shift is either potentially related to their reduced need to engage in employment or to support their ability to balance their roles in both productivity and reproduction. Therefore, it appears essential to adopt a comprehensive gender-oriented approach to support breastfeeding and establish a balanced work-family dynamic between men and women to enhance the nutritional well-being of all family members. Further research should delve into the complexities of devising an effective approach to women's empowerment that can lead to better outcomes for women themselves and those in their social spheres concerning nutrition, health, and the reduction of socio-economic disparities.

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Titre : Inégalités socio-économiques, genre et malnutrition dans les pays en développement.

Résumé : Cette thèse comprend trois essais en économie appliquée, se situant à la croisée de l'économie du développement, de l'économie de la santé et des études de genre. Son objectif principal est d'éclairer diverses problématiques liées aux inégalités face au risque de malnutrition dans les pays en développement, en les analysant à travers le prisme du genre. Le premier chapitre examine l'impact de l'autonomisation des femmes, mesurée par leur capacité à agir au quotidien, sur la malnutrition infantile au Népal, indépendamment du statut socio-économique de ces femmes. Le deuxième chapitre teste l'hypothèse d'une évolution des pratiques d'allaitement maternel en Asie en corrélation avec l'enrichissement économique des ménages et des nations. Enfin, le troisième chapitre explore l'influence d'un changement d'attitude envers les rôles de genre sur la prévalence mondiale de l'obésité pour chaque sexe, ainsi que sur l'évolution des inégalités entre hommes et femmes face au risque d'obésité. Les réponses à ces questions reposent sur l'analyse de données micro et macroéconomiques secondaires, en utilisant des méthodes statistiques et économétriques diversifiées.

Mots clés : Inégalités ; Genre ; Malnutrition ; Pratiques d'allaitement ; Obésité ; Autonomisation ; Statut socioéconomique ; Asie.

Title : Socio-economic inequalities, gender and malnutrition in developing countries.

Abstract : This thesis consists of three essays in applied economics at the intersection of development economics, health economics and gender studies. Its main aim is to shed light on various issues related to inequalities in the face of malnutrition risk in developing countries by analysing them through a gender lens. The first chapter examines the impact of women's empowerment, as measured by their ability to take action on a daily basis, on child malnutrition in Nepal, regardless of women's socio-economic status. The second chapter tests the hypothesis that changes in breastfeeding practices in Asia are correlated with the economic wealth of households and nations. Finally, the third chapter examines the influence of changing attitudes to gender roles on the global prevalence of obesity for each sex and changes in gender inequalities in obesity risk. The answers to these questions are based on the analysis of secondary micro- and macroeconomic data based on a large set of statistical and econometric methods.

Keywords : Inequality; Gender; Malnutrition; Breastfeeding practices; Obesity; Empowerment; Socio-economic status; Asia.
