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**MEASURING WOMEN'S EMPOWERMENT AND ITS
IMPACT ON CHILD DEVELOPMENT IN AFRICAN
COUNTRIES: AN ANALYSIS OF NATIONAL SURVEYS**

PhD THESIS

FERNANDA EWERLING

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IMPACT ON CHILD DEVELOPMENT IN AFRICAN
COUNTRIES: AN ANALYSIS OF NATIONAL SURVEYS**

This thesis was presented to the Postgraduate Program of Epidemiology from the Universidade Federal de Pelotas to complete the requirements of a PhD in Epidemiology degree.

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COUNTRIES: AN ANALYSIS OF NATIONAL SURVEYS**

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To my family.

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It is funny how hard it is for me to write this section. I've never been good with words, especially expressing my feelings. However, I really want to express my gratitude to some people that were tremendously important during my PhD (and perhaps my whole academic and personal life).

First, I would like to thank my supervisor Professor Aluísio Barros for always trusting my work (and myself) and for always pushing me to go further. Before the master's you were already a researcher model for me. After a master's and a PhD as my supervisor, you also became a great friend. You led me opening new perspectives in life, and I will be always grateful. THANK YOU!

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Living in a different country with a different culture and language would be much harder without friends. Leticia, Helena and Dandara, you are really important to me, and I am grateful for every moment we had together.

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and taught me the letters, syllables and suddenly the words started making sense to me. In that day she did not just taught me how to read, she taught me about love. My parents always told me and my sister about the importance of education. Your strength and dedication always inspired me, therefore my work is dedicated to you.

Resumo

Ewerling, Fernanda. **Measuring women's empowerment and its impact on child development in African countries: an analysis of national surveys**. Tese de doutorado. Programa de Pós-graduação em Epidemiologia. Universidade Federal de Pelotas; 2015.

Os objetivos de desenvolvimento sustentável apresentam um grande enfoque na redução de iniquidades. O objetivo 5, especificamente, visa a eliminação das desigualdades de gênero e o empoderamento de todas as mulheres e meninas, reforçando a necessidade de ter um indicador que possibilite a mensuração do progresso dos países com relação a esta meta. O empoderamento das mulheres tem potencial para gerar mudanças que podem impactar positivamente a economia e os indicadores de saúde, tanto nos núcleos familiares quanto nas comunidades. O primeiro objetivo desta tese foi desenvolver um indicador de empoderamento feminino utilizando dados de inquéritos DHS (do inglês *Demographic and Health Surveys*) de 34 países africanos, possibilitando assim o monitoramento do empoderamento das mulheres na região (artigo 1). O indicador proposto, denominado SWPER (em inglês, *Survey-based Women's emPowERment*), é composto por 15 itens e permite a avaliação de três domínios de empoderamento: postura com relação à violência, independência social e tomada de decisão. O SWPER possibilita a comparações dentro do país (entre indivíduos ou subgrupos) entre países, bem como a análise de tendências temporais. Nenhum outro índice baseado em inquéritos permite comparações entre países ou ao longo do tempo. Utilizando o SWPER, foi avaliada a associação entre o empoderamento das mulheres e um indicador composto de cobertura de intervenções de saúde (*Composite Coverage Index*, CCI). O CCI é calculado como uma média ponderada da cobertura de oito intervenções em saúde reprodutiva, materna, neonatal e infantil (artigo 2). Também foi avaliado se esse efeito seria modificado pelo nível de riqueza. Utilizando dados do DHS para 36 países da África, encontramos uma associação positiva entre os três domínios do SWPER e o CCI em nível do país. Uma mudança de um desvio padrão no empoderamento feminino aumentou o CCI em 15 (postura com relação à violência e tomada de decisão) e 23 pontos percentuais (independência social). Para este último, a associação foi modificada pela riqueza: cada desvio padrão adicional mostrou-se associado com 39,0 (IC 95%: 26,2 - 51,9) pontos percentuais de aumento no CCI entre os mais pobres e 9,7 (IC95%: 5,1 - 14,3) pontos percentuais entre o quintil mais rico. Também usando o SWPER, avaliamos o efeito do empoderamento da mãe no desenvolvimento da criança (artigo 3). Para isso, foi utilizado um indicador de desenvolvimento infantil desenvolvido pela

UNICEF (ECDI, em inglês *Early Childhood Development Index*), que permite a avaliação de quatro domínios do desenvolvimento, a saber: alfabetização (originalmente denominado *literacy-numeracy*), físico, aprendizagem e socioemocional. Em média, 14,3%, 92,0%, 80,4% e 65,7% das crianças encontravam-se com desenvolvimento adequado nos domínios de alfabetização, físico, aprendizagem e socioemocional, respectivamente. Para cada aumento de um desvio padrão no empoderamento da mãe nos domínios de postura com relação à violência, independência social e tomada de decisão, as chances de a criança estar com desenvolvimento adequado em alfabetização aumentou em 31%, 90% e 31%, respectivamente. No entanto, o efeito do empoderamento da mãe sobre o desenvolvimento físico, de aprendizagem e socioemocional da criança foram muito pequenos ou nulos, o que pode estar relacionado à baixa variabilidade desses desfechos. No geral, nossos resultados sugerem que os esforços para alcançar o quinto objetivo de desenvolvimento sustentável (Alcançar a igualdade de gênero e empoderar todas as mulheres e meninas) no continente africano podem ter um impacto importante na saúde materna e infantil, bem como no desenvolvimento da criança, em especial no domínio da alfabetização.

Palavras-chave: Empoderamento das mulheres; autonomia; Saúde materna; serviços de saúde materno-infantil; desenvolvimento infantil.

Abstract

Ewerling, Fernanda. **Measuring women's empowerment and its impact on child development in African countries: an analysis of national surveys.** Thesis (PhD). Postgraduate Program in Epidemiology. Universidade Federal de Pelotas; 2015.

The Sustainable Development Goals strongly focus on equity. Goal 5 explicitly aims to empower all women and girls, reinforcing the need to have a reliable indicator to track progress. Women's empowerment has a strong potential to improve health and economic outcomes both in the households and communities. The first objective of this thesis was to develop a novel women's empowerment indicator using Demographic and Health Survey (DHS) data from 34 African countries, broadening opportunities for monitoring and research on women's empowerment in the region (paper 1). The proposed indicator, named Survey-based Women's empowerment (SWPER), composed by 15 items, allows the assessment of three empowerment domains: attitude to violence, social independence and decision making. It allows within-country and between-country comparison, as well as time trend analysis, which no other survey-based index provides. This indicator was then used to evaluate the association between women's empowerment and the Composite Coverage Index (CCI), a weighted average of coverage with eight interventions in reproductive, maternal, newborn and child health (paper 2). We also assessed whether these effects are modified by wealth. Using DHS data for 36 countries, we found a positive association between the three SWPER domains and the CCI at country level. One standard deviation change in empowerment increased the CCI by 15 (attitude to violence and decision-making domains) and 23 percentage points (social independence). For the latter, the association was modified by wealth: each additional standard deviation was associated with 39.0 (95% CI: 26.2 – 51.9) percentage points increase in the CCI among the poorest and 9.7 (95% CI: 5.1 – 14.3) percentage points among the richest quintile. Also using the SWPER, we evaluated the effect of the mothers' empowerment on the development on the child (paper 3). To do so, we used the Early Childhood Development Index, which allows the assessment of four developmental domains, namely literacy-numeracy, physical, learning and socioemotional. On average, 14.3%, 92.0%, 80.4% and 65.7% of the children were on track for literacy-numeracy, physical, learning and socioemotional developmental domains, respectively. Overall, for each standard deviation increase in attitude to violence, social independence and decision-making scores, the odds for the child being on track on literacy-numeracy increased 31%, 90% and 31%, respectively.

However, the mothers' empowerment overall effects on the physical, learning and social-emotional development of the child was very small or null, which may be related to the low variability in these outcomes. Overall, our findings suggest that efforts toward the achievement of SDG5 (Achieve gender equality and empower all women and girls) may have an important impact on both maternal and child health, as well as on the development of the child in literacy-numeracy on the African continent.

Keywords: Women's empowerment; personal autonomy; maternal health; maternal-child health services; child development.

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Presentation

This PhD thesis was produced under the supervision of Professor Aluísio JD Barros, and co-supervision of Professor John Lynch during a period of study at The University of Adelaide, Australia. The document is composed by the PhD research project, a description of the fieldwork as a member of the International Center for Equity in Health (ICEH), three original scientific articles and a press release with the main findings of the thesis. According to the decision of the Postgraduation in Epidemiology Department Board, that agreed with the project modification, the literature review article originally planned in the PhD research project was replaced with another original article.

The first article presented in the thesis is titled “The SWPER index for women’s empowerment in Africa: development and validation of an index based on survey data” and was published at The Lancet Global Health on July 26, 2017; the second one, “Does women’s empowerment increase coverage of RMNCH interventions in Africa? An analysis using a survey-based empowerment indicator, the SWPER” was submitted to the Social Science and medicine on April 2018; and the third article, “the impact of women’s empowerment on their children’s early development in 16 African countries” will be submitted to The Lancet Global Health. The articles were all formatted according to the journal’s instructions.

PhD Research Project



UNIVERSIDADE FEDERAL DE PELOTAS

Postgraduate Program in Epidemiology



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PhD Research Project

FERNANDA EWERLING

Supervisor: Aluísio J D Barros (Federal University of Pelotas, Brazil)

Co-supervisor: John Lynch (University of Adelaide, Australia)

July, 2016.



UNIVERSIDADE FEDERAL DE PELOTAS

Postgraduate Program in Epidemiology



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The presentation of this PhD research project is mandatory for obtaining a doctoral degree from the Postgraduate Program in Epidemiology - Federal University of Pelotas, Brazil.

July 2016.

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1 Executive summary

Background

The Sustainable Development Goals (SDGs) proposed by the United Nations (2015-2030) have a strong focus on equity, goal 5 explicitly aiming at the achievement of gender equality and the empowerment of all women and girls. However, no standard survey-based measurement has yet been proposed, which turns accountability in low-and middle-income countries impossible. In consequence, this goal, that was already among in the Millennium Development Goals, remains overlooked by the countries' governments and policy makers. The empowerment of women and girls is a goal in itself and also as a promoter of diverse development spheres, as the economic growth, reduction of poverty and the accomplishment of human rights. Its relevance is highlighted for its high potential of generating changes in the familiar context and, also, in their children health outcomes. More empowered women are more likely to provide their children with appropriate care and nutrition, which improves their chances to survive and properly develop. The early childhood development has also been included among the SDGs, indicating that children should not only survive, they should thrive (and shine).

Objective

The main purpose of this research project is to develop a survey-based women's empowerment (WE) index comparable across countries and time, describe how countries compare in regards to it, and analyze the impact of WE on children's early development in the context of the African countries.

Methods

To develop the survey-based women's empowerment index, we will take advantage of the large amount of data already available in the Demographic and Health Surveys, which is one of the main sources of information available in low- and middle-income countries. With this indicator in hand, we aim to assess its association with early childhood development using modern epidemiological methods including structural equation modelling.

2 Glossary of terms and abbreviations

CD	Child's development
DHS	Demographic and Health Survey
ECDI	Early Child Development Index
EW&G	Empowerment of Women and Girls
GDI	Gender Development Index
LMIC	Low- and Middle-Income Country
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
SDG	Sustainable Development Goal
UNDP	United Nations Development Program
WE	Women's Empowerment

3 Planned articles

1. Measurable aspects of women's empowerment and the existing survey-based indicators: a literature review;
2. Development of a survey-based women's empowerment index for Africa;
3. The impact of women's empowerment on their child's early development in African countries.

4 Background

The reduction of gender inequalities and the empowerment of women and girls are key objectives of development policy (1). Given the tremendous success of the Millennium Development Goals (MDGs), last year the United Nations announced the much more ambitious Sustainable Development Goals (SDGs)¹. Unlike the MDGs, the SDGs have a strong focus on equity, goal 5 explicitly aiming at the achievement of gender equality and the empowerment of all women and girls (EW&G). Supporting women's agency to improve their livelihoods and their ability to claim rights and influence decisions is, thus, essential to achieve this goal (2). In other words, the SDGs reflect the necessity to give women better opportunities (3) as no society can advance its development with half of its population being marginalized (4).

In low and middle income countries (LMICs), most women are still deprived of claiming their rights and of being able to make decisions about the direction of their lives (5). In some places, even women's freedom to obtain healthcare for herself or for her children is denied. Reaching gender equity is a slow process, since it challenges people to change many cultural practices and thoughts (5). It takes far more than changes in law or stated policy to change practices in households and communities, especially because their implementation can be undermined by social norms (6).

The literature on women's empowerment (WE) is relatively recent, having become more popular in the mid-1980s (7). WE is a complex concept for which many definitions exist. One of the most cited in the literature describes it as "the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them" (8). For the World Bank, it is "the process of enhancing an individual's or group's capacity to make purposive choices and to transform those choices into desired actions and outcomes" (2). It requires women to be autonomous in all areas of life, inside and outside the household (9) and means a step closer to the life one wishes to live (10). Due to diverse cultural changes, many countries are achieving progress in this important goal (5). However, the countries that advanced more in this direction are mostly rich and developed (5, 9, 11).

¹ Available in <https://sustainabledevelopment.un.org/sdgs> (Accessed on April 27th, 2016).

The empowerment of women and girls (EW&G) is a goal in itself and also as a promoter of diverse development spheres, as economic growth, reduction of poverty and the accomplishment of human rights (2). Its relevance is highlighted for its high potential of generating changes in the familiar context. The literature shows that it is also positively associated with diverse health outcomes and interventions, as modern contraceptive use, access to maternal interventions as antenatal care and skilled birth attendance (12-14). WE is also associated with the desire for a smaller number of children, even though this finding is not consistent across the sub-Saharan African countries analyzed. This lack of consistency is possibly related to the cultural norms, in the sense that in some countries a high fertility is something socially expected (15). It is a common discussion in multi-country studies that WE itself and its relation with outcomes will be different for each context (16).

The gender context also has a central role in children health outcomes (17). Ideal development of the children's brain requires a stimulating environment, social interactions with dedicated caregivers and adequate food and nutrients intake are essential (18). Findings from a study conducted in sub-Saharan Africa and South Asia showed that the more women controlled the economic resources in the household, the more money was spent with their children (19). Thus, more empowered women are also more likely to provide their children with appropriate care and nutrition, improving their chances to survive and properly develop (20).

Women's empowerment is a challenging concept to measure because of its abstract and comprehensive nature definition (21-23). Some indices have been proposed for low- and middle-income countries (LMIC) using Demographic and Health Survey (DHS) data, which incorporated a specific empowerment module since the late 1990s(12-16, 19, 23-27). The DHS is one of the main sources of reliable and standardized information from LMICs. These indicators are essentially based in this DHS empowerment module, that includes questions on the woman's involvement in household decisions; employment and type of earnings; control over resources; opinion on wife beating; and personal ownership of house/land. These indices have three major limitations: (a) the weights are subjectively chosen, with no theoretical or statistical guidance; (b) are only applied to partnered women; and (c) they were designed for specific countries or regions, not allowing the comparison of many countries. The DHS country reports also present two empowerment indices, one composed of decision-

making questions and another based on the number of reasons for which the woman thinks wife beating is justified as measures of women's empowerment. Again, these indices are subjectively weighted and lack comparability as not the same questions are available in all surveys, and different questions are considered in the indices.

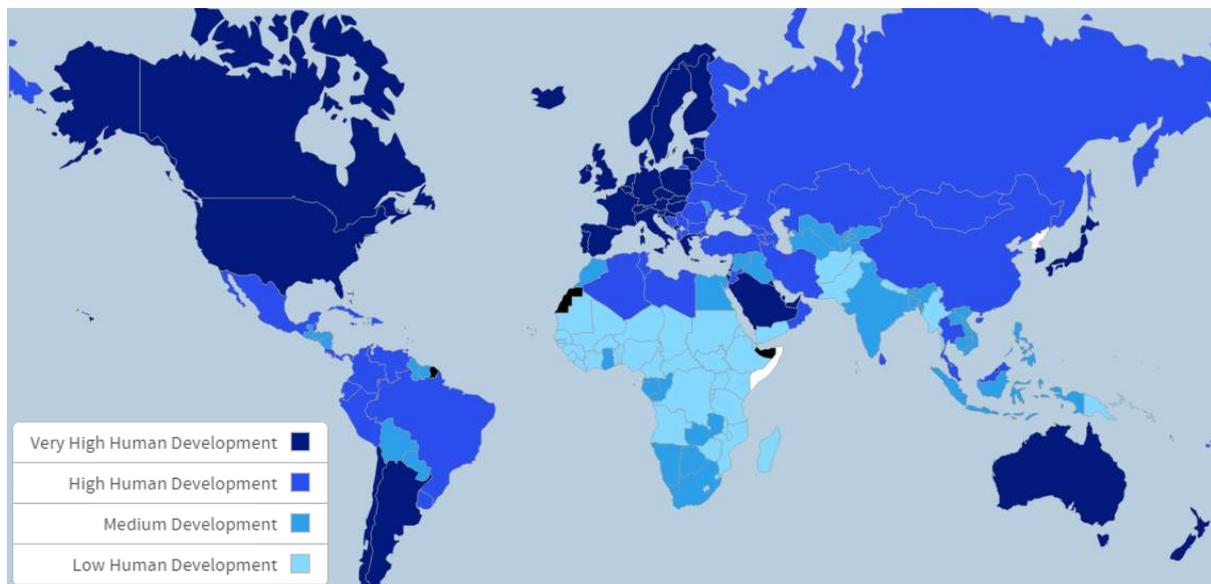
Gender indicators are key to uphold governments and policy makers committed to gender equity and sustainable development, because everything that is measurable is more likely to be prioritized (21). However, a cross-cultural standard indicator has not yet been proposed. Having a specific SDG on this topic reinforces its importance and the need to have a standard indicator to track the countries' achievements in this field (3). Also, to our knowledge, the relation of women's empowerment and child development have never been directly assessed, and this possibility for LMICs only came up recently with the inclusion of these information in national household surveys.

Our main objective is to develop an indicator of women's empowerment based on DHS data that allows further research on this topic in the context of LMICs, taking advantage of a large amount of readily available data. We aim for an indicator that will allow us to compare countries and monitor their evolution over time regarding WE, what is extremely important to hold countries accountable for their commitment to the fifth SDG. Besides, considering the effect that WE has on diverse health and development outcomes (24, 28), we aim to analyze the impact of WE on early child development in the context of the African countries.

5 African context

Besides the extreme poverty experienced by many African countries, Figure 1 also shows that their human development index (HDI) levels are also among the lowest levels in the world. Still, large differences are found comparing the African countries. Also, Table 1 shows the gross domestic product per capita at purchase power parity (GDP per capita, PPP) in international dollars for the ten most populated countries in Africa. These information evidences that generally the eastern, middle and western regions are the poorer ones, in agreement with the HDI. The south and northern regions are the one with better off countries in terms of GDP and HDI.

Figure 1. Human Development Index worldwide



Source: United Nations Development Programme (UNPD). International Human Development Indicators. Available from: <http://hdr.undp.org/en/countries> [Accessed Oct 29,2016].

Table 1. Gross Domestic Product (GDP) per capita at purchase power parity (PPP), 2015.

Region	Country	GDP 2015, PPP (I\$) ¹
Eastern	Congo DR	783
	Ethiopia	1626
	Uganda	1825
	Tanzania	2667
	Kenya	3083
Middle	Sudan	4173
Western	Nigeria	5992
Northern	Egypt	10891
	Algeria	14687
Southern	South Africa	13165

Note: ¹ in current international dollars (I\$)

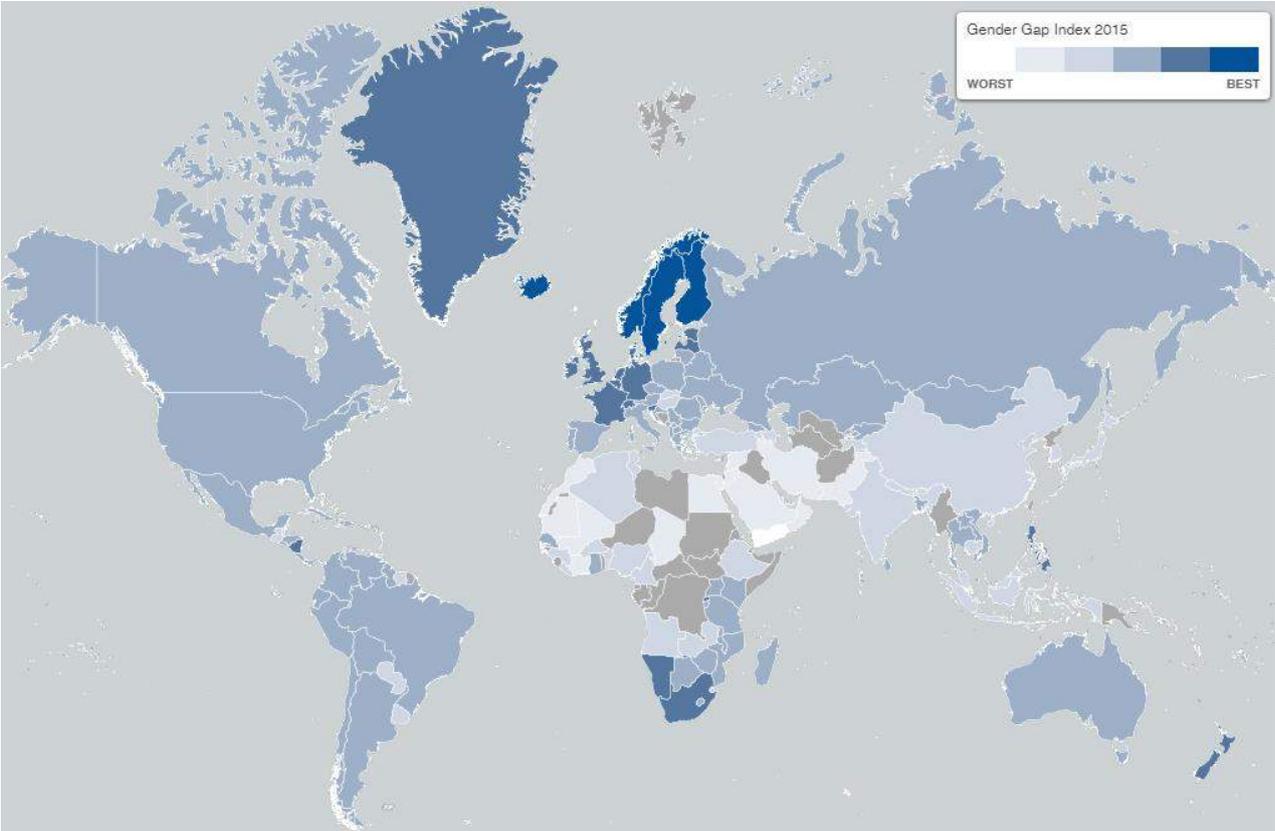
Source: World Bank, International Comparison Program database.

Available from: <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD> [Accessed Oct 29,2016].

In relation to the women and girl’s situation, we know that they have experienced improvements in diverse aspects of their lives worldwide. However, they still suffer great deprivations and inequalities persist because of the gender discrimination (29). The Gender Gap Index quantifies the magnitude of the gender inequalities in four key areas: health,

education, economy and politics (30). According to this index, no country in the world had achieved gender equality in these areas. Figure 2 below presents a heat map of the country rankings. Many countries in Africa and South Asia do not have data available, but it is clear that these regions comprise the majority of the worse country rankings in the world. The exceptions are South Africa and Namibia, that are among the top 16 countries. Western and Middle African countries present the largest gaps in secondary education enrolment, having only 79 girls enrolled for every 100 boys (29).

Figure 2. Gender Gap Index 2015 – heat map of the countries’ ranking



Source: World Economic Forum. Gender Gap Index 2015. Available from: <http://reports.weforum.org/global-gender-gap-report-2015/#frame/dd4ad> [Accessed Oct 29,2016].

6 Women's empowerment overview: definitions and measurement

6.1 Women's empowerment – concept definition

Gender represents the different roles, rights and obligations people are linked to, given their biological sex characteristic. Gender norms are incorporated in diverse social institutions, including the households, where it is continuously reproduced (17). Also, as fewer and worse opportunities in the labor market are offered to women, the parents and even the women and girls themselves do not have great aspirations for their future, which may contribute to the perpetuation of their unequal treatment (28). Gender equality and women's empowerment are closely related but have different concepts. While gender equality refers to equal rights, responsibilities and opportunities of men and women, women's empowerment is related to the women's ability to make decisions about their own life and destiny.

Some gender aspects are particularly challenging to conceptualize and measure, and that is case for women's empowerment (7). It has been conceptualized using diverse terms besides WE, including women's autonomy, status and agency (15). There are many different definitions of WE and its interpretation is often divergent even within organizations (2). One of the most cited in the literature defines it as "The expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them." (8). WE is also described as a process that strengthens agency, which enables women to access services and resources, and to make better informed decisions as an individual and/or as member of a group (24). For the World Bank, it is "the process of enhancing an individual's or group's capacity to make purposive choices and to transform those choices into desired actions and outcomes." (2). It requires the women to be autonomous in all areas of life, inside and outside the household (9). It is also important to recognize that women just advance in terms of empowerment when they have self-efficacy, that is, when they can envisage a different future or situation and consider themselves not only able, but also entitled to make decisions (1).

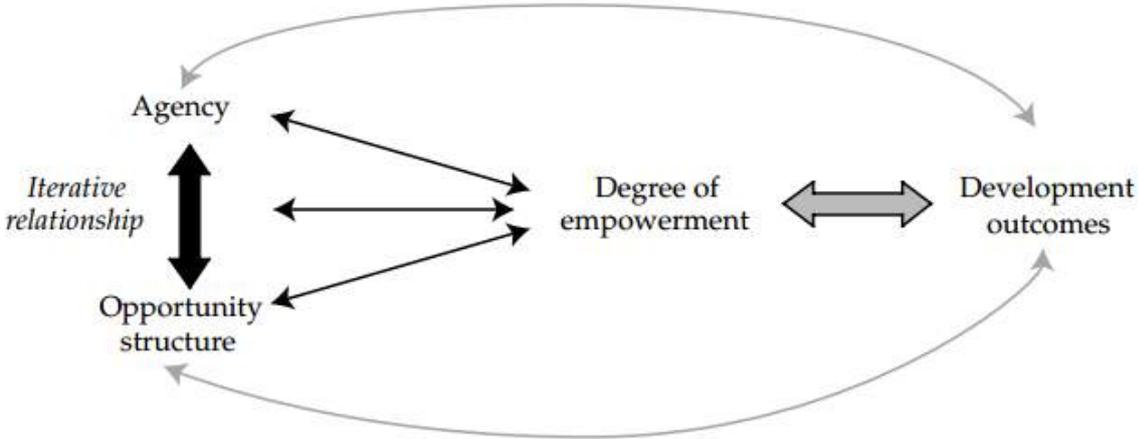
The notion that empowerment is not about 'power *over*' others, but 'power *to*' achieve goals is inherent to all the definitions previously described. It identifies WE as a process that

involves the understanding of women’s rights and the development of the conscience that gender norms can be changed, so that gender inequity can be overcome (31).

Gender inequity should be explicitly and intentionally confronted, so that health and development outcomes can be equally achieved by women and men (4). In this sense, WE also increases self-confidence and motivates women to question and confront gender norms and inequitable structures, as well as to hold governments and providers accountable to guarantee the offer of gender-responsive services (24).

The World Bank proposed a general WE framework that can be used in different contexts. As Figure 3 shows, the degree of empowerment relies on the existence of agency and opportunity structure (2). The authors define agency as the ability to make informed and purposeful decisions and the opportunity structure is the set of institutions that transform this agency into action. They assume that both formal (e.g. the legal framework) and informal (e.g. gender norms) institutions play a role in the woman’s degree of empowerment. Both these factors interact to determine the empowerment level.

Figure 3. Women’s empowerment framework

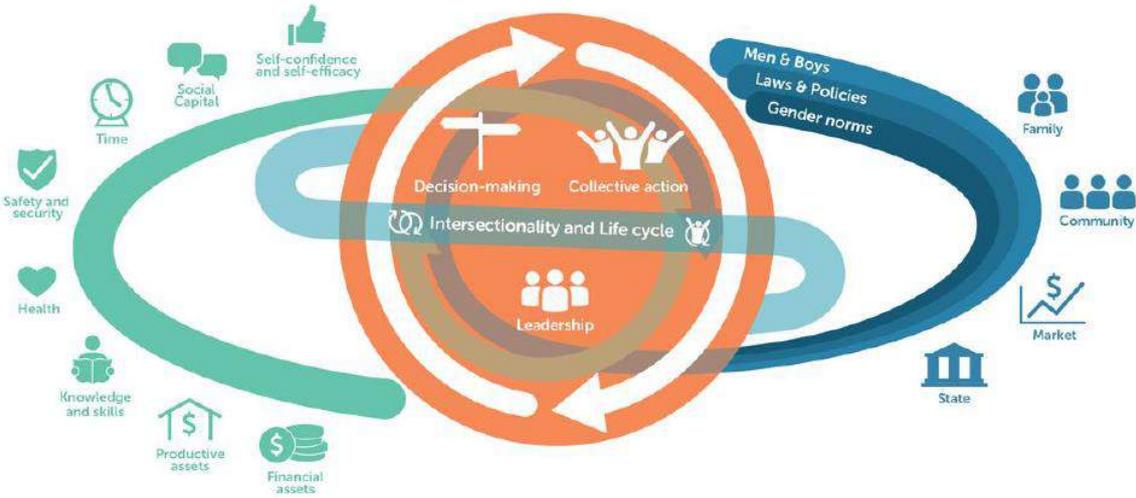


Source: Reprinted from Alsop R, Bertelsen MF, Holland J. Empowerment in practice: From analysis to implementation: World Bank Publications; 2006. p. 10.

It is suggested that investments and interventions can empower women by focusing in the iterative process existent between opportunity structures and agency. Their theory is that interventions to expand women’s agency and to give them better opportunities can increase their capacity to make effective choices, which can lead to diverse desired actions and outcomes (2).

The KIT (Royal Tropical Institute, Amsterdam) gender group has been working in the outline of the conceptual model for EW&G presented in Figure 4, having the World Bank framework as one of their main inspirations. They describe empowerment as a process of change caused and affected by the interaction of three key factors: agency, assets and institutional structures (32).

Figure 4. Conceptual model of the empowerment of women and girls



Source: Reprinted from Eerdewijk Av, Newton J, Tyszler M, Wong F, Vaast C. A. Conceptual Model of Empowerment of Women and Girls (draft). In: KIT Gender (Royal Tropical Institute), editor. Amsterdam, 2016. p. 10 [work-in-progress].

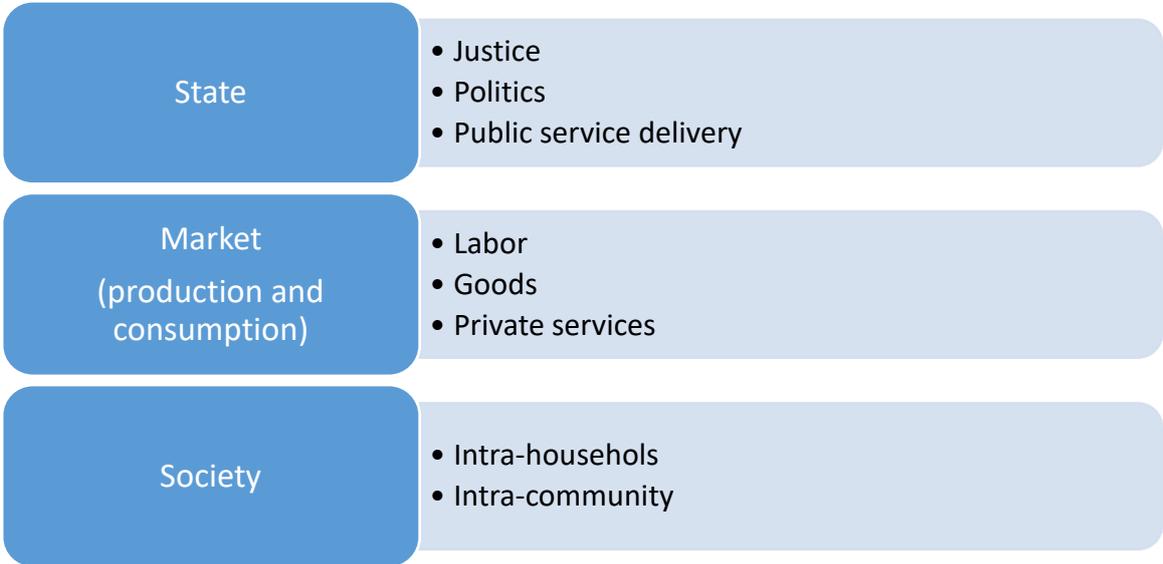
Agency is at the center of the empowering process and is characterized as the women’s capacity for “purposive action”. In the model, it is expressed as their involvement in decision-making, collective actions and leadership. Assets and institutional structures, which interact

with agency in this process, are described respectively as the women’s stock of resources and skills and the context-specific social arrangements of formal and informal rules and practices. Empowerment is considered a transformative process of change that contests the relations of power existent in each context. Thus, this dynamic interaction between agency, assets and institutional structures can lead it to different and unpredictable directions on this process.

The multiple dimensions of WE have been broadly discussed in the literature, and like the concept definition, there is no consensus across the literature. These dimensions are generally very broad, so their appropriate measurement usually requires a set of variables to be used to capture the underlying latent construct of WE (1).

Based on the cross-cultural WE framework presented in Figure 1, the World Bank defined three broad empowerment domains: state, market and society, in which women are civic, economic and social actors, respectively. They further divided it in eight subdomains as presented in Figure 5.

Figure 5. Women’s empowerment domains defined by the World Bank



In the agriculture field, the Women’s Empowerment in Agriculture Index (WEAI) is based in five domains: (1) decisions over agricultural production, (2) access to and decision-making

power over productive resources, (3) control over use of income, (4) leadership in the community, and (5) time allocation.

Economic, socio-cultural, familial/interpersonal, legal, political and psychological are among the most common dimensions of WE described in the literature (33). It should be also noted that each of these dimensions can be assessed at the household, community and/or societal levels, and all of them must be considered when developing a WE indicator.

In the next section, we present a literature review on the survey-based (especially DHS-based) WE indicators available in the literature. Table 1 illustrates the domains and their operationalization in each of these indicators. Access and control over resources, decision-making and attitude to violence are among the most mentioned ones.

Despite all the described diversity in the conceptualization of WE, there is a link between some of the key terms used to define it (1). Also, some terms are repeated in many of these definitions, as it is the case of “choice”, “control”, “agency” and “freedom”. In this research project, we will employ a working concept based in these definitions, considering that the degree of empowerment is defined by the woman’s capacity to make strategic life choices.

6.2 Measures of women’s empowerment

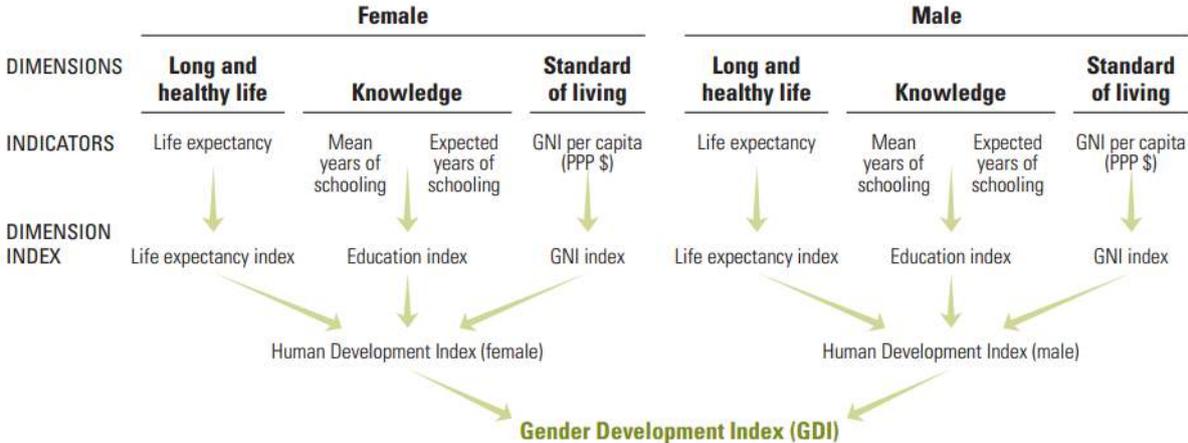
WE is a challenging concept from a measurement perspective because it has an abstract and broad definition (22). It is determined by various individual and community factors and its interactions, and is also context-specific in the sense that its definition – and consequently its measure – differ from one place, situation, or even from one individual to another (24). Thus, to effectively measure WE, a set of multi-dimensional indicators are necessary. To capture these complexities, some organizations are even including qualitative data in their indicators (7).

The measurement of this kind of construct is a technical exercise, but the choice of what to include is also a political process that reflects the priorities of those who are developing the indicator (7, 21). To do so, evidence of empowerment should be sought in indicators of

women’s control over diverse aspects of their life and environment, along with indicators suggesting a rejection of gender-based subordination (34).

Several WE indicators have been proposed at group level, condensing national or regional information. Some examples of these aggregated measures, that generally are presented at country level, are the Gender Gap Index (5), developed by the World Economic Forum, the Gender Development Index and the Gender Inequality Index, both developed by the United Nations Development Programme (UNDP) (9). The Gender Gap Index was introduced in 2006 and ranks the countries according to the extent to which women have achieved equality with men in five key areas: economic participation and opportunity, political empowerment, educational attainment and health and survival (30). As presented in Figure 6, the Gender Development Index measures gender inequalities in three aspects of human development— health; education; and command over economic resources – using the same methodology of the Human Development Index calculation.

Figure 6. Graphical presentation of the Gender Development Index calculation

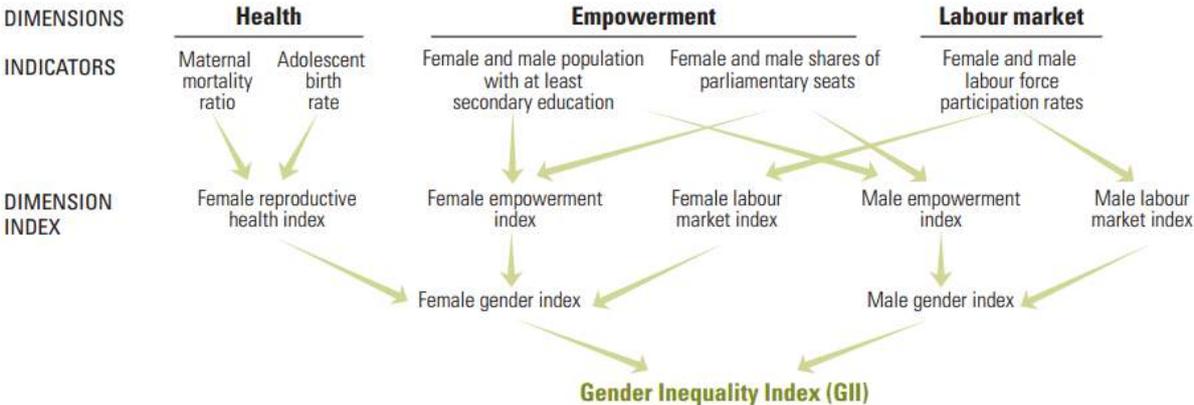


Source: United Nations Development Programme (UNPD). Human Development Report 2015 – Technical Notes. Available from: <http://hdr.undp.org/en/content/gender-inequality-index-gii> [Accessed Aug 02,2016].

The Gender Inequality Index is a composite measure that reflects inequalities in achievements comparing men and women in reproductive health, empowerment and labor market. As it is

shown in Figure 7, the health component, which is basically on reproductive health, is only included in the female index.

Figure 7. Graphical presentation of the Gender Inequality Index calculation



Source: United Nations Development Programme (UNPD). Human Development Report 2015 – Technical Notes. Available from: <http://hdr.undp.org/en/content/gender-inequality-index-gii> [Accessed Aug 02,2016].

A limitation of these indicators is that as they use national-level data, within-country inequities are overlooked (1). There is also concern in the literature about the reliability of this kind of data (7).

Oxfam built an individual indicator of WE to assess the impact of interventions on the empowering process (22). This indicator was designed as an individual score based on five domains, each composed by a set of variables, as it is shown in Table 2. This indicator covers most of the WE aspects. However, as it was designed to assess interventions’ impact, thinking that the data would be collected in each project area, most of the needed information is not available in the health surveys. This limits the use of the indicator for LMICs, where data availability relies heavily on these data.

The Women’s Empowerment in Agriculture Index (WEAI) is one of the most cited survey-based indices. It is an aggregated index based on individual data. It was designed to assess WE in five domains (decisions over agricultural production, access to and decision-making

power over productive resources, control over use of income, leadership in the community, and time allocation) and gender parity in terms of WE comparing men and women from the same household, both in the agricultural context (1). Still, the information needed to calculate it is not available in the health surveys.

Table 2. Dimensions and characteristics included in the Oxfam indicator

Dimension	Characteristics
Ability to make decisions and influence	<ul style="list-style-type: none"> Involvement in household investment decisions Involvement in livelihood management decisions Involvement in income-spending decisions Involvement in general decisions Degree of influence in community decision-making
Self-perception	<ul style="list-style-type: none"> Opinions on women’s property rights Opinions on women’s political rights Opinions on women’s educational equality Opinions on women’s economic and political roles Opinions on early marriage Self-confidence Psycho-social well-being
Personal freedom	<ul style="list-style-type: none"> Literacy Autonomy in work Time to pursue personal goals Support from family in pursuing personal goals Attitude to violence against women Experience of violence
Access to and control over resources	<ul style="list-style-type: none"> Ownership of land and property Ownership of other productive assets Independent income Extent of role in managing/keeping family’s cash Savings Access to credit
Support from social networks	<ul style="list-style-type: none"> Degree of social connectivity Participation in community groups Level of support provided by groups to pursue own initiatives

Note: Reprinted from “Still learning: a critical reflection on three years of measuring women's empowerment in Oxfam”, by Bishop D and Bowman K., 2014, Gender & Development, p. 261.

Also, using the rationale of creating a WE indicator based on a survey, (35) used factor analysis to extract the domains of socio-economic position from a study conducted in the two poorest

areas of Egypt (Assiut and Sohag). They identified four components: Socio-cultural resourcefulness, economic resourcefulness, dwelling quality and women's status. The latter was based in the women's freedom of mobility to (1) leave house; (2) go to the market; (3) go to hospital; (4) visit relatives and neighbors; and (5) run an errand; as well as the participation in decisions about the household budget and on visits to friends or relatives. However, most of the variables related to freedom of mobility are not available in the national health surveys. DHS has only one question on whether the woman can go to a health center/hospital alone or with her young children. However, this question is not among the 'core' questions, so it is not available in all surveys.

Some indices have been proposed using survey data in the health surveys context, and a summary of them is shown in Table 3. Each of the studies proposed distinct measures of WE. All of them were developed using DHS survey data, that includes a specific module on this topic in its questionnaires since the late 1990s (31). Most of the indicators found are essentially based in this module, which includes questions on the woman's involvement in some household decisions; employment and form of earnings; control over resources; attitude towards wife beating – based on her opinion if it is justified the husband to beat his wife in some situations; and personal ownership of house or land. Since this module is only applied to partnered women, all the indicators are restricted to them. Also, we found that most the WE measures were subjectively weighted, which means the relative weights given to each aspect was selected in an arbitrary way. Generally, an equal weight was given to all questions. It is unlikely that all aspects have the same value, and this simplistic approach lack of explicit value judgement (36).

Table 3. Survey-based indicators available in the literature.

Author (Year)	Indicator	Countries	WE measure	Limitations
Upadhyay <i>et al.</i> (2012)	DHS Women's Empowerment indices	Four Sub-Saharan African countries (Guinea, Mali, Namibia and Zambia)	<p>1. Index of women's participation in household decisions</p> <p>Corresponds to the number of decisions in which women participate alone or jointly with their husbands/partners. The number of questions vary, most of the countries include 3 out of 5. In this paper, they used 4 questions:</p> <ol style="list-style-type: none"> 1.1. Their own health care; 1.2. Large household purchases; 1.3. Daily household purchases; and 1.4. Visits to their family or relatives; <p>Higher scores indicate higher empowerment levels.</p> <p>2. Index of women's attitudes towards wife beating</p> <p>Ranges from 0 to 5 and corresponds to the total number of reasons for which the respondent thinks that a husband is justified in beating his wife:</p> <ol style="list-style-type: none"> 2.1. If she goes out without telling him; 2.2. If she neglects the children; 2.3. If she argues with him; 2.4. If she refuses to have sex with him; 2.5. If she burns the food. <p>Higher scores indicate lower empowerment levels.</p> <p>3. Women's attitudes towards refusing sex with their husband</p>	<p>Subjectively weighted;</p> <p>Restricted to partnered women;</p> <p>Questions of the third score are not available in many surveys.</p>

Author (Year)	Indicator	Countries	WE measure	Limitations
			<p>Women were asked if a wife is justified in refusing to have sex with her husband if:</p> <p>3.1. She knows her husband has a sexually transmitted disease;</p> <p>3.2. She knows her husband has had sex with other women; and</p> <p>3.3. She is tired or not in the mood.</p> <p>This is not a composite DHS index, but in the paper, they separated women who stated that all the reasons are justified (higher WE level) and those who said one or more reasons are not justified.</p>	
Tuladhar <i>et al</i> (2013)	Women's Empowerment Index (WEI)	Nepal	<p>WE measured individually as a composite index, ranging from 0 to 7, which was based on:</p> <p>1. Women's involvement in household decision-making about:</p> <p>1.1. Their own health care;</p> <p>1.2. Large household purchases; and</p> <p>1.3. Visits to their family or relatives;</p> <p>2. Membership in community groups, such as mothers' group, saving group, women's group, and others.</p> <p>3. Cash earnings, which indicates if the woman earns cash. If she does not work or does not earn cash at all, she was given score of zero.</p> <p>4. Ownership of house or land</p>	<p>Subjectively weighted;</p> <p>Restricted to partnered women;</p> <p>Question on membership in community group is very context-specific, so it is not among the 'core' DHS variables.</p>

Author (Year)	Indicator	Countries	WE measure	Limitations
Jennings <i>et al</i> (2014)	Women's empowerment status	Eight selected sub-Saharan African countries: Burkina Faso, Burundi, Malawi, Mozambique, Rwanda, Senegal, Uganda and Zimbabwe.	<p>5. Education, categorized as none (0); primary (1) and secondary or higher (2)</p> <p>Total scores were then categorized as low (0-2 total score), moderate (3-4) and high (5-7) level of empowerment.</p> <p>WE measured individually as a composite index, ranging from 0 to 9, with 3 dimensions. Each item is counted as one point in the total score.</p> <p>1. Economic - access and control over resources and participation in economic markets:</p> <p>1.1. Women's income relative to partner; 1.2. Decision on woman's income use; 1.3. Decision on partner's income use; 1.4. Decision on household purchases.</p> <p>2. Socio-familial - women's freedom to mobility and power balance within social networks.</p> <p>2.1. Decision on own health care; 2.2. Attitude towards partner violence – this item includes all five questions on attitude to violence and it is given one score for women that answered it is not justified the husband to beat the wife in any of the situations.</p> <p>3. Legal - Women's judicial and legislative entitlements, including land and property rights.</p> <p>3.1. Home ownership;</p>	Subjectively weighted; Restricted to partnered women; Questions 3.1 and 3.2 are not available in many surveys.

Author (Year)	Indicator	Countries	WE measure	Limitations
			3.2. Land ownership.	
Ahmed <i>et al.</i> (2010)	Women's economic, educational and empowerment status - the 3Es	33 countries for which all variables were available	<p>Economic status Poorest vs. Lowest wealth quintile</p> <p>Educational status Complete primary vs. No or incomplete primary education</p> <p>Empowerment status Composite score ranging from 0 to 5 calculated as the sum of positive (yes) answers given to five questions about women's involvement in decisions related to:</p> <ol style="list-style-type: none"> 1. Their own health care; 2. Large household purchases; 3. Daily household needs purchases; 4. Visits to their family or relatives; and 5. daily meal preparation. 	<p>Subjectively weighted; Restricted to partnered women; Includes only the decision-making questions in the Empowerment status, which is only one domain of WE; Questions 3 and 5 are not available in many surveys.</p>
Na <i>et al.</i> (2015)	Women's empowerment	Ten Sub-Saharan African countries (Benin, Burkina Faso, Ethiopia, Mali, Niger, Nigeria,	<p>Women's empowerment was assessed by nine standard items covering three dimensions:</p> <p>1. Economic</p> <ol style="list-style-type: none"> 1.1. relative income to husband/partner; 1.2. Control over men's income; 1.3. Control over women's income; 1.4. Decision making on large household purchases <p>2. Socio-familial</p> <ol style="list-style-type: none"> 2.1. Decision making regarding family visits; 	<p>Subjectively weighted; Restricted to partnered women; It is not clear how they measured women's health (2.2); Questions 3.1 and 3.2 are not available in many surveys.</p>

Author (Year)	Indicator	Countries	WE measure	Limitations
		Rwanda, Sierra Leone, Uganda and Zimbabwe)	<p>2.2. Women’s own health;</p> <p>2.3. Attitude towards domestic violence under five scenarios</p> <p>3. Legal</p> <p>Women’s judicial and legislative entitlements</p> <p>3.1. Land; and</p> <p>3.2. House</p> <p>Authors aggregated the items using dichotomous codes, with 1 indicating higher empowerment. Total score ranged 0 to 9. For each dimension and total score, women were categorized based on whether her score was higher or lower than the country-specific mean.</p>	
Wekwete et al. (2014)	Women’s empowerment indicators	Zimbabwe	<p>1. Control over women’s income;</p> <p>2. Control over partner’s income;</p> <p>3. Women’s ownership of house/land;</p> <p>4. Participation in household decision making;</p> <p>5. Women’s attitudes towards wife beating; and</p> <p>6. Relative income to husband/partner;</p>	Article does not create a WE indicator. Instead, they analyzed each variable separately.
Msuya et al. (2014)	Women’s empowerment	Tanzania	<p>Indicator based on the women’s involvement in household decision-making about:</p> <p>1.1. Their own health care;</p> <p>1.2. Large household purchases; and</p> <p>1.3. Visits to their family or relatives;</p> <p>Women were coded “1” if they had a say in all three situations, and “0” otherwise.</p>	<p>Subjectively weighted;</p> <p>Restricted to partnered women;</p> <p>Includes only the decision-making questions in the Empowerment status, which is only one domain of WE.</p>

Author (Year)	Indicator	Countries	WE measure	Limitations
Tadesse et al. (2013)	Women's empowerment	Ethiopia	<p>Indicator presented four components derived with principal component analysis:</p> <ol style="list-style-type: none"> 1. Acceptance of subordinate gender norms –women's attitudes towards domestic violence Respondent thinks that a husband is NOT justified in beating his wife: <ol style="list-style-type: none"> 1.1. If she goes out without telling him; 1.2. If she neglects the children; 1.3. If she argues with him; 1.4. If she refuses to have sex with him; 1.5. If she burns the food; 2. Household decision making: <p>Involvement in household decision-making about:</p> <ol style="list-style-type: none"> 2.1. Their own health care; 2.2. Large household purchases; 2.3. Visits to their family or relatives; and 2.4. Control over partner's income; 3. Knowledge exposure: <ol style="list-style-type: none"> 3.1. Respondent is aware of a law in Ethiopia to prevent partner violence; 3.2. Complete years of education; 3.3. Frequency of reading newspaper or magazine; 3.4. Frequency of watching television. 4. Ownership of assets: <ol style="list-style-type: none"> 4.1. Women's ownership of a house; 	<p>Restricted to partnered women; Question 3.1 is context-specific.</p>

Author (Year)	Indicator	Countries	WE measure	Limitations
			4.2. Women's ownership of land;	
Afifi et al. (2009)	Women's empowerment	Egypt	<p>Composite score ranging from 0 to 5 calculated as the sum of positive answers given to five questions about women's involvement in decisions related to:</p> <ol style="list-style-type: none"> 1. Their own health care; 2. Large household purchases; 3. Daily household needs purchases; 4. Visits to their family or relatives; and 5. daily meal preparation. 	<p>Subjectively weighted;</p> <p>Restricted to partnered women;</p> <p>Includes only the decision-making questions in the Empowerment status, which is only one domain of WE;</p> <p>Questions 3 and 5 are not available in many surveys, which restrict the use of the indicator.</p>
Shimamoto and Gipson (2015)		Senegal and Tanzania	<p>Indicator presented four factors derived with principal component analysis:</p> <ol style="list-style-type: none"> 1. Household decision-making power Involvement in household decision-making about: <ol style="list-style-type: none"> 1.1. Their own health care; 1.2. Large household purchases; and 1.3. Visits to their family or relatives; ++ Summative variable captured the number of decisions in which women participated. 2. Perceptions of gender norms against violence Respondent thinks that a husband is NOT justified in beating his wife: <ol style="list-style-type: none"> 2.1. If she goes out without telling him; 2.2. If she neglects the children; 	<p>Principal component analysis was used only to determine the WE domains, scores were then subjectively weighted using the “++” variables;</p> <p>Restricted to partnered women;</p> <p>Question related to sex negotiation are not available in many surveys.</p>

Author (Year)	Indicator	Countries	WE measure	Limitations
			2.3. If she argues with him; 2.4. If she refuses to have sex with him; 2.5. If she burns the food; ++ Summed scale capturing the number of situations in which women do NOT accept the violence. 3. perceptions of gender norms for sex negotiation 3.1. Can refuse sex; 3.2. Can ask partner to use a condom ++ Summative variable captured the number of situations in which women thinks she can negotiate with husband. 4. Age at first marriage	
Do and Kurimoto (2012)	Women's empowerment	Namibia, Zambia, Ghana and Uganda	Used principal component analysis separately for each domain's set of variables to create an index: 1. Economic empowerment 1.1. woman's income relative to her husband's 1.2. Control over women's income; 1.3. Control over partner's income; Decision-making Involvement in household decision-making about: 1.4. Large household purchases 1.5. Daily household purchases 2. Sociocultural 2.1. Involvement in decision-making about visits to family and relatives	Domains were 2, 3 and 4 have only one variable in their composition, which does not seem to embrace the domain as a whole; Restricted to partnered women; Questions related to negotiation on sexual relations are not available in many surveys.

Author (Year)	Indicator	Countries	WE measure	Limitations
			<p>3. health-seeking behavior</p> <p>3.1. Involvement in decision-making about seeking healthcare for the herself</p> <p>4. Agreement on fertility preferences</p> <p>4.1 Whether she thought she and her partner wanted the same number of children;</p> <p>5. Negotiation regarding sexual activity</p> <p>Whether the woman can:</p> <p>5.1 Refuse to have sex with partner;</p> <p>5.2. Ask him to use a condom</p> <p>Whether she thinks a woman is justified some situations to:</p> <p>5.1 Refuse to have sex with partner;</p> <p>5.2. Ask him to use a condom</p> <p>6. Attitudes toward domestic violence</p> <p>Respondent thinks that a husband is NOT justified in beating his wife:</p> <p>6.1. If she goes out without telling him;</p> <p>6.2. If she neglects the children;</p> <p>6.3. If she argues with him;</p> <p>6.4. If she refuses to have sex with him;</p> <p>6.5. If she burns the food;</p>	

Some of the questions included in these indicators are particularly tricky, and even inappropriate to be included in a measure of WE. Various authors included the question related to the women's income relative to the partner's. This comparison is not as simple as it seems, because they can have different levels of education, occupation, and so on. On the control over the partner's earnings, another variable commonly included, it should be noted that gender equity is about everyone having personal freedom to make choices. Therefore, it should not be expected that empowering women would increase their control over her partner's income.

It was also common the inclusion of the variable related to the woman's type of earnings from work (cash, in kind or not paid at all). It can be tricky to add this information because it is directly related to the household wealth. Besides, the ownership of house or land should be used carefully as the inheritance rules are complicated and vary greatly across countries.

Two authors also included the decision on what to cook on their indicators. However, we consider that it might not be related to higher empowerment levels, as it can be either a mandatory woman's task, or even something related to the availability of food in the household. Besides, this question is not available in many surveys.

As we showed, there are many different survey-based WE indicators available. However, none of these measures can be used to compare many countries. A great challenge to do so is the variation across countries regarding their cultural contexts. Thus, to have a valid cross-national indicator, one should identify universally recognized measures of WE (15).

7 Early child development and women's empowerment

The period comprehended from the moment the child is born to the five years of age is a critical period for their cognitive, social, and physical development. This is an important window for investments, since interventions focused on early childhood development (ECD) are considered the most cost-effective approaches to increase educational achievements and productivity in adulthood (18). However, every year more than 200 million children under five years from LMICs fail to achieve their full potential in cognitive development (37). The international community embraced the cause, putting it as a right for every child. This meant

that it was not enough that children survive, it should be ensured that they also thrive. The SDG includes a target on attaining equal and universal early childhood development by 2030.

In addition to its importance to economic development, WE is also an important determinant of diverse health outcomes and access to diverse health interventions (13). The gender context also has a central role in the children health outcomes (17). Empowered women are more likely to work and to have control over economic resources, which often means control over food purchases. Thus, it is described as a key factor that mediate the household resources to provide their children with appropriate feeding practices (18).

The environment is a key determinant of their chances to survive and develop properly. A stimulating environment, social interactions with dedicated caregivers and adequate food and nutrients intake are essential for the ideal development of the brain (18). Studies conducted in sub-Saharan Africa and South Asia found that the more women control the economic resources in the household, the more money is spent with their children (19). Thus, more empowered women are also more likely to provide their children with appropriate care and nutrition, improving their chances to survive and properly develop (20).

Even with this global and growing interest in ECD, data from LMICs are still very limited. It may be because most the measures available were created with developed countries in sight, and they are not appropriate for use in the LMICs context (38). To fill this gap, a group of researchers from UNICEF developed the Early Child Development Index (ECDI) especially for this context (18). It is a cross-culturally tested tool that has only ten simple questions (see Table 4), which can be applied to the caregivers by a regular trained interviewer.

Table 4. Early childhood development module

QUESTION
EC8. Can (name) identify or name at least ten letters of the alphabet?
EC9. Can (name) read at least four simple, popular words?
EC10. Does (name) know the name and recognize the symbol of all numbers from 1 to 10?
EC11. Can (name) pick up a small object with two fingers, like a stick or a rock (stone) from the ground?
EC12. Is (name) often too sick to play?
EC13. Does (name) follow simple directions on how to do something correctly?
EC14. When given something to do, is (name) able to do it independently?
EC15. Does (name) get along well with other children?
EC16. Does (name) kick, bite, or hit other children or adults?
EC17. Does (name) get distracted easily?

The ECDI have already been criticized on two of these domains. It is argued that although the three items on literacy/numeracy are relevant indicators of pre-academic knowledge, they would be more likely to reflect differences in countries' social/cultural than the children's cognitive capacity. Furthermore, the literacy/numeracy items are considerably advanced compared to pre-academic skills captured in comparable tools. Another domain criticized in the literature is the physical, as the pincer grasp represents a skill normally developed before one year of age, and then would only capture severe developmental setbacks in children aged 3-4. Besides, the second item on the physical domain – being too sick to play – would represent the children's health status rather than their early developmental skills (39). Besides all the criticism about the indicator, it is a great advance to have a global measure available in the LMIC, especially because it makes the countries accountability possible.

8 Objectives

8.1 General objective

Develop a survey-based women's empowerment index comparable across countries and time and, describe how countries compare in regards to it, and analyze the impact of WE on their children's early development in the context of the African countries.

8.2 Specific objectives

1. Based on the most accepted concepts of WE and available information in national health surveys, develop a WE indicator using the DHS series of surveys, evaluating the differences between and within the African countries.
 - a. Evaluate the indicator external validity of the indicator by assessing its correlation with the Gender Development Index, a recognized measure of gender inequality developed by the UNDP;
 - b. Evaluate the indicator internal (convergent) validity thru the assessment of its association with use of modern contraception, institutional delivery and under-five child stunting;
 - c. Compare countries at national level in terms of the WE indicator domains;
 - d. Assess within-country inequalities in WE across wealth quintiles, geographic regions and area of residence (urban/rural)
2. Study the association between the proposed WE indicator and child development in the African countries.
 - a. Explore the original ECDI operationalization proposed by UNICEF (18) and alternatives using either principal components analysis or structural equation model-based factor analysis
 - b. Assess the magnitude of impact and its variation across countries
 - c. Understand which dimension of WE, if any, is more strongly associated with CD

9 Hypothesis

We expect that the WE index will be multi-dimensional, that is, it will represent different domains of empowerment.

As women's empowerment is context-specific, we also expect that these domains of empowerment will present some variation across the analyzed countries. We expect the domains to include some different items and the items to have different weights in different regions.

We expect that the index will be moderately correlated with the Gender Development Index, because it has a very different methodology, and is based in aggregated information from the countries.

In general, we expect to find positive associations between our index and use of modern contraception and antenatal care; and a negative association with stunting. However, due to cultural differences, especially religion and social norms, the association of the WE index with some interventions (e.g. modern contraception use) can vary greatly across countries. Using the same example, we would expect WE effect on modern contraceptive use to be positive, however in some countries it can be negative, especially because of religious or social norms.

Wealth can be a confounder, so when we adjust the analysis by it, the magnitude of the effect will be reduced in some countries.

As empowerment means more freedom and autonomy to make choices, we suppose that more empowered women will be more autonomous on what age to marry and to have children, as well as they will have fewer children compared to the less empowered. All these aspects will have a positive effect in their children's health, and specifically, in the child's early development as measured by the ECDI.

We also expect that the association of WE and CD will be greater in the poorer countries, where the children are more poorly developed and in the countries with greater gender gaps.

10 Methods

10.1 Literature Review paper

In the first article of the thesis, we aim to discuss all the aspects that compose the empowerment domains, and their measurability. We will compile all women's empowerment measures based on Demographic and Health Survey (DHS) data, one of the main sources of standardized information from LMICs. Many of these studies are published as reports, which makes it harder to find them. Thus, we will proceed the search in different sources, as the PubMed, POPLINE, standard and scholar Google, and the DHS website.

10.2 Data Source

We will use data from the DHS and Multiple Indicator Cluster Survey (MICS), which are nationally representative cross-sectional surveys with multiple waves/rounds in each country. MICS and DHS have standardized data collection procedures across countries, so they yield highly comparable data, which support several analyses to track health and population trends in LMICs. These surveys contain both 'core' and optional modules, so each survey is adapted to the country in each it will be conducted (40). The surveys include: (1) a household questionnaire; (2) women's questionnaire, which is generally for individuals aged 15-49 years; (3) children's questionnaire, usually conducted for the 0-4 completed years; and (4) men's questionnaire, that is not available in all surveys.

The surveys methodology comprises a two-stage sampling selection process. Firstly, the geographical areas are randomly selected, taking the probability of selection into account. Then, the fieldwork teams visit the selected areas, where a complete list of dwellings and households is collected. From these lists, 20–30 households are selected by systematic sampling. The selected households are visited by a trained interviewer, who conducts a brief household interview, and identifies the eligible respondents (41). In general, the surveys present a very high response rate (typically exceeds 90%) (40).

DHS incorporated more specific gender-related measures in the core questionnaire in 1999 (31). Initially, this module was developed for the Asian context, but it has later been included in the 'core' DHS questionnaire (15). These questions rely on the woman's participation in household decision making; employment and form of earnings; control over resources; attitude towards wife beating – based on her opinion if it is justified the husband to beat his wife in some situations; and personal ownership of house or land. MICS is much more limited regarding this topic and does not include any specific module.

The inclusion of the Early Childhood Development Index (ECDI) module in health surveys is very recent. The MICS incorporated the ECDI questions since 2009 (fourth round of surveys) and some DHS started collecting this information in 2010 (their sixth wave of surveys) (39). It is already a standard module in the MICS questionnaire, but is still being included in the new DHS. In Africa, particularly, the ECDI module on DHS is only available for West and Central Africa countries.

10.3 Development of the women's empowerment index

10.3.1 Inclusion/exclusion criteria

All women aged 15-49 years with complete data will be included in the analysis. As most of the available questions related to this topic are restricted to partnered women, the unpartnered ones will be excluded.

10.3.2 Variables relevant to women's empowerment

Our first step was to identify all the questions available in most DHS and MICS surveys that could reflect some dimension of WE, based on the literature. This was a tough task, which involved raising questions like "how to define WE?"; and "how to measure it?". WE has been most commonly measured using the DHS women's empowerment module, but these questions are limited to the household domain (1). However, many other questions related to strategic life choices are available in these surveys and can be also considered, such as the

early marriage and pregnancy, which can represent the woman’s ability to choose the occurrence and timing of these events (16).

We took a pragmatic approach of listing all potential questions possibly related to the most commonly recognized dimensions of WE, such as autonomy, self-respect and decision making. These questions are shown in Table 5, below.

Table 5. Potential indicators of women’s empowerment from DHS and MICS questionnaires.

QUESTION	CATEGORIES	DHS	MICS
What is the highest level of school you attended?	0 No education		
	1 Primary	x	x
	2 Secondary		
	3 College or higher		
What is the highest class you completed at that level?	-- Class	x	x
Are you currently working?	1 Y	x	
	2 N		
What is your occupation, that is, the kind of work do you mainly do?		x	
How often do you read a newspaper or magazine: almost every day, at least once a week, less than once a week or not at all?	1 Almost every day		
	2 At least once a week	x	x
	3 Less than once a week		
	4 Not at all		
Do you personally have a mobile phone?	1 Y	x	
	2 N		
Total children ever born	Number children	x	x
Age of respondent at first birth	Age in years	x	x
How old were you when you started living with your first husband/partner?	Age in years	x	x
Are you currently doing something or using any method to delay or avoid getting pregnant?	1 Y		
	2 N	x	x

QUESTION	CATEGORIES	DHS	MICS
Now I would like to ask you some questions about the future. Would you like to have (a/another) child, or would you prefer not to have any (more) children?	1 Have (a/another) child 2 No more / None 3 Says she cannot get pregnant 8 Undecided / Don't know	x	x
Would you say that using contraception is mainly your decision, mainly your (husband's/partner's) decision, or did you both decide together?	1 Mainly respondent 2 Mainly husband/partner 3 Joint decision 6 Other	x	
Does your (husband/partner) want the same number of children that you want, or does he want more or fewer than you want?	1 Both want same 2 Husband wants more 3 Husband wants fewer 8 DK	x	
How old was your (husband) on his last birthday? (see difference)	Age in years	x	x
Husband's total number of years of education (see difference)	Education in years	x	
Aside from your own housework, have you done any work in the last seven days?	1 Y 2 N	x	
As you know, some women take up jobs for which they are paid in cash or kind. Others sell things, have a small business or work on the family farm or in the family business. In the last seven days, have you done any of these things or any other work?	1 Y 2 N	x	
Although you did not work in the last seven days, do you have any job or business from which you were absent for leave, illness, vacation, maternity leave, or any other such reason?	1 Y 2 N	x	
Have you done any work in the last 12 months?	1 Y 2 N	x	
Are you paid in cash or kind for this work or are you not paid at all?	1 Cash only 2 Cash and kind 3 In kind only	x	

QUESTION	CATEGORIES	DHS	MICS
	4 Not paid		
Who usually decides how the money you earn will be used?	1 Mainly respondent 2 Mainly husband/partner 3 Joint decision 6 Other	x	
Who usually makes decisions about health care for yourself?	1 Mainly respondent 2 Mainly husband/partner 3 Joint decision 4 Someone else 6 Other	x	
Who usually makes decisions about making major household purchases?	1 Mainly respondent 2 Mainly husband/partner 3 Joint decision 4 Someone else 6 Other	x	
Who usually makes decisions about visits to your family or relatives?	1 Mainly respondent 2 Mainly husband/partner 3 Joint decision 4 Someone else 6 Other	x	
Who usually makes decisions about your child health care?	1 Mainly respondent 2 Mainly husband/partner 3 Joint decision 4 Someone else 6 Other	x	
Can you go to a health center or hospital alone or with your young children?	1 Yes, alone 2 Yes, with children 3 No 6 Other	x	
Sometimes a husband is annoyed or angered by things that his wife does. In your opinion, is a husband justified in hitting or beating his wife in the following situations:		x	x

QUESTION	CATEGORIES	DHS	MICS
[A] IF SHE GOES OUT WITHOUT TELLING HIM?	Y / N / DK		
[B] IF SHE NEGLECTS THE CHILDREN?	Y / N / DK		
[C] IF SHE ARGUES WITH HIM?	Y / N / DK		
[D] IF SHE REFUSES TO HAVE SEX WITH HIM?	Y / N / DK		
[E] IF SHE BURNS THE FOOD?	Y / N / DK		
Have you ever used a computer?	1 Y 2 N		x
During the last one month, how often did you use a computer: almost every day, at least once a week, less than once a week or not at all?	1 Almost every day 2 At least once a week 3 Less than once a week 4 Not at all		x
Have you ever used the internet?	1 Y 2 N		x
During the last one month, how often did you use the internet: almost every day, at least once a week, less than once a week or not at all?	1 Almost every day 2 At least once a week 3 Less than once a week 4 Not at all		x
Do you think this practice (female circumcision) should be continued, or should it be discontinued?	1 Continued 2 Stopped 3 Depends 8 DK	x	x
How satisfied are you with your family life?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x
How satisfied are you with your current job?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x

QUESTION	CATEGORIES	DHS	MICS
How satisfied are you with your health?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x
How satisfied are you with where you live?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x
How satisfied are you with how people around you generally treat you?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x
How satisfied are you with your life, overall?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x
How satisfied are you with your current income?	1 Very satisfied 2 Somewhat satisfied 3 Neither satisfied nor unsatisfied 4 Somewhat unsatisfied 5 Very unsatisfied		x
Compared to this time last year, would you say that your life has improved, stayed more or less the same, or worsened, overall?	1 Improved 2 More or less the same 3 Worsened		x

As the MICS questionnaire was considerable poorer in regard to WE-related information, we decided to include in our analyses only the DHS. To be included in the indicator, these variables should be: (1) highly relevant; (2) available in all surveys to be analyzed; and (3) context unspecific (universally recognized measures). Initially, we identified 23 variables as candidates for our analyses; after checking availability and further theoretical assessment eight were excluded, mainly because they were not available in a large number of surveys (see Table 6 for more details) and 15 variables were selected to compose the indicator. The list of variables selected is shown in Table 7.

Table 6. DHS variables excluded from the empowerment index and reasons for exclusion.

Variable	Reason for exclusion
Who usually decides on daily household purchases	Not available in all surveys
Whether she can refuse to have sex with the husband	Not available in all surveys
Ever used anything or tried to delay or avoid getting pregnant	Not available in all surveys
Type of earnings from respondent's work	Asked only to women employed in last year
Can you go to a health center or hospital alone or with your young children?	Not available in all surveys
Decision maker for using contraception	Asked only to women using contraception
Ownership of house or land	Not available in all surveys
Ownership of a personal mobile phone	Usually a household question; personal information is not available in all surveys.

One of the selected variables is age at first birth but there is a considerable number of partnered women with no children at the time of the survey (average of 7.7% of the women, ranging from 4% in Zambia to 17.5% in Comoros). Thus, we need to impute data for these cases to prevent them from being dropped. To do so, we will use single hotdeck imputation. This method randomly selects the value to be imputed for a missing case from a group of individuals that are similar to it in terms of a variable or a group of variables. In this case,

women will be clustered in groups of age at first cohabitation. This variable was selected because it had the highest correlation with age at first birth, and other variables did not add much predictive power in a regression model.

Table 7. Variables used in the development of the survey-based women’s empowerment index.

Variable	Code or unit
Beating NOT justified if:	
1. wife goes out without telling husband	
2. wife neglects the children	
3. wife argues with husband	Yes = -1; DK=0; No=1
4. wife refuses to have sex with husband	
5. wife burns the food	
6. Frequency of reading newspaper or magazine	Not at all=0; <once a week=1; ≥once a week=2
7. Respondent worked in last 12 months	No = 0; In the past year = 1; Have a job, but on leave last 7 days = 2; Currently working = 2
8. Woman education in completed years of schooling	Years
9. Education difference: woman’s minus husband’s years of schooling	Years
10. Age difference: woman’s minus husband’s age	Years
11. Age at first cohabitation	Years
12. Age of woman at first birth*	Years
Who usually decides on:	
13. Respondent's health care	Husband/other alone= -1; joint=0;
14. Large household purchases	respondent alone=1
15. Visits to family or relatives	

* This variable was imputed for women who had not had a child, please see the article methods for details.

10.3.3 Development of the women's empowerment index

We selected the African continent because most of its countries are among those with lower women's empowerment levels (9, 30). In Asia, women are also extremely marginalized, and face huge difficulties but these countries will not be included in these studies because we believe that gender issues are highly context-specific to countries. The latest survey available for each country will be used in the analysis. The list of countries included in the analysis are presented in Table 8.

Table 8. List of latest DHS surveys from Africa included in the analyses and number of women in the samples.

Country	Year	N	Country	Year	N
1. Benin	2011	11206	18. Malawi	2010	15067
2. Burkina Faso	2010	13192	19. Mali	2012	8737
3. Burundi	2010	5138	20. Morocco	2003	8619
4. Cameroon	2011	9039	21. Mozambique	2011	8643
5. Comoros	2012	2930	22. Namibia	2013	3520
6. Congo DR	2013	12045	23. Niger	2012	9165
7. Côte d'Ivoire	2011	5817	24. Nigeria	2013	26500
8. Egypt	2014	20406	25. Rwanda	2014	6778
9. Ethiopia	2011	10004	26. S Tomé & Príncipe	2008	1715
10. Gabon	2012	4100	27. Senegal	2014	5251
11. Gambia	2013	6423	28. Sierra Leone	2013	10254
12. Ghana	2014	5343	29. Swaziland	2006	1888
13. Guinea	2012	6641	30. Tanzania	2010	6233
14. Kenya	2014	8833	31. Togo	2013	6161
15. Lesotho	2009	4069	32. Uganda	2011	5150
16. Liberia	2013	5708	33. Zambia	2013	9088
17. Madagascar	2008	11102	34. Zimbabwe	2010	5444

We will then use principal component analysis to extract the WE components out of each country dataset. These results will be carefully analyzed to check if there is any between country consistency, that is, if the components and loadings are similar across countries. Having a consistency in any specific African region, we intend to combine the countries' datasets and generate a single WE index for all of them. This approach is similar to the development of the International Wealth Index, by Smits and Steendijk (42) and allows within- and between-country comparison, as well as time trend analysis. The latter is essential to track the countries changes regarding WE, making them accountable in SDG 5.

10.4 Association between women's empowerment and early childhood development

10.4.1 Inclusion/exclusion criteria

All children aged 3-4 years old with complete data will be included in the analysis. Cases in which the child does not live with the mother and there is no complete information about her will be excluded. As the empowerment index will be restricted to partnered women, children from single mothers will also end up excluded from the analysis.

10.4.2 Child development as measured in surveys

The Early Childhood Development Index (ECDI), a cross-culturally tested tool developed by UNICEF, is a multidimensional index composed of ten questions directed to the child's mother or primary caregiver designed to assess the development of children aged 3 and 4 complete years (36-59 months old) (39). The interviewer begins this part of the interview stating "I would like to ask you some questions about the health and development of your child. Children do not all develop and learn at the same rate. For example, some walk earlier than others. These questions are related to several aspects of your child's development.", and then she asks the CD questions, which were presented in Table 4.

The ECDI design allows the assessment of four development domains: literacy/numeracy, physical, learning and social-emotional. The operationalization of the index, that is, the rules

used to determine whether the children are developmentally on track are showed in Box 1 (18). The response categories for all the questions are “yes”, “no”, and “don’t know”.

Box 1. Operationalization of the ECDI in children aged 3-4 complete years.

- (1) *Literacy/numeracy (EC8-EC10)*: Children are considered developmentally on track if at least two of the following is true: Can identify/name at least ten letters of the alphabet; can read at least four simple, popular words; knows the name and recognizes the symbol of all numbers from 1 to 10.
- (2) *Physical (EC11-EC12)*: Children are considered developmentally on track if one or both of the following is true: can pick up a small object with two fingers, like a stick or a rock from the ground; is not sometimes too sick to play.
- (3) *Learning (EC13-EC14)*: The child is identified as being developmentally on track if one or both of the following is true: follows simple directions on how to do something correctly; when given something to do, is able to do it independently.
- (4) *Social-emotional (EC15-EC17)*: The child is identified as being developmentally on track if at least two of the following is true: gets along well with other children; does not kick, bite, or hit other children; does not get distracted easily.

According to ECDI, the child is developmentally on track if at least three of the four component domains was considered to be on track.

The ECDI module has been included in the questionnaires of the surveys for the first time in the fourth MICS round (18) and the sixth DHS wave (39). The availability of these data in the African countries' surveys, as well as its sample sizes, are presented in Table 9.

Table 9. Data availability of ECDI module on MICS and DHS surveys in the African countries.

Region	Country	Year	Type	Round/ Wave	Sample size ¹
Eastern & Southern Africa	Malawi	2011	MICS	4	7719
Eastern & Southern Africa	Swaziland	2011	MICS	4	1081
Eastern & Southern Africa	Zimbabwe	2010	MICS	4	3907
West & Central Africa	Cameroon	2011	DHS	6	3201
West & Central Africa	Central African Republic	2012	MICS	4	3797
West & Central Africa	Chad	2010	MICS	4	7104
West & Central Africa	Chad	2010	DHS	6	3995
West & Central Africa	Congo Brazzaville	2010	DHS	6	4958
West & Central Africa	DR Congo	2014	DHS	6	5465
West & Central Africa	DR Congo	2010	MICS	4	4056
West & Central Africa	Ghana	2010	MICS	4	3080
West & Central Africa	Mauritania	2011	MICS	4	3726
West & Central Africa	Nigeria	2014	MICS	5	10268
West & Central Africa	Sierra Leone	2011	MICS	4	3688
West & Central Africa	Togo	2011	MICS	4	1812
West & Central Africa	Togo	2014	DHS	6	3723

Note: ¹Children 3-4 years of age.

10.4.3 Statistical analysis

As the ECDI have already been criticized in the literature, we intend to test different alternatives to classify the children in terms of development using its questions:

1. Original on-track classification;
2. Create a score using the set of variables that compose the test using factor analysis;
3. Find cut-off points for low development score (e.g. cut-off for the 1st decile) for age groups in a way to limit the effect of age on the children's performance.

Considering the conceptual model to be defined, that will guide confounder adjustment, we will carry out analyses using structural equation modelling to assess the association between women's empowerment and early childhood development.

11 Relevance and impact

The Sustainable Development Goals put gender equity and empowerment of women and girls high in the agenda. These are even more pressing in countries with lower income and lower levels of education. Therefore, it was a priority to close the gender data gap and to develop a women's empowerment indicator that could be used in LMICs.

The indicator we aim to propose has a great potential to widen the research field on WE, and specially, to give a better picture of its effect on maternal, reproductive and child health outcomes. The methodology we intend to employ will allow within- and between-country comparison, as well as time trends analysis. It would be the its main strength as no other cross-cultural indicator with these features has yet been proposed. By allowing a large amount of research, it will open a brand-new perspective for this research field.

There is no established evidence about the association between the mother's degree of empowerment and her child's development achievements. We will take advantage of the novel WE indicator to do so. Considering the growing interest in both WE and CD, in case we find a positive effect, this study can influence the countries' programs, policies and, potentially, even their gender norms.

12 Limitations

One major limitation is that we have to work with the data available in the surveys. The indicator's scope is limited by the fact that DHS data do not cover all dimensions and levels of empowerment (13), and for instance say little on economic and political participation and leadership of women, nor on rights to resources and other forms of discrimination against

women. However, given the breadth of questions available in health surveys, we believe it will be possible to derive some relevant aspects related to women's empowerment.

Another important limitation is that MICS and DHS have a strong focus on maternal and reproductive health. Then, a great number of questions - and sometimes the entire survey - are only applied to women that are currently in a union. Consequently, as the indicator will be an individually estimated, unpartnered women will end up excluded from the analysis. Thus, it will be estimable only for partnered women. This can be up to 62% of the women in Namibia. This is a paradox given that many empowered women are not necessarily partnered or will end up marrying only later in life. Disabled women and sex workers, who are among the most marginalized and disempowered ones might also not be partnered, and, thus they are not included in the index.

We recognize that the African countries present extremely different contexts in regards to gender equity. Then, we should be very careful when interpreting the results as the same variable can have different meanings depending on the context (i.e. work could represent empowerment in the sense that more empowered women can have a choice about it and, consequently, more independence; otherwise, it could represent disempowerment if the woman is forced to work by the husband or anyone else).

In regards to the ECDI, which already have been criticized in the literature, we understand that it is not a strong measure. MICS and DHS are multipurpose surveys that already have very extensive questionnaires. In general, the most common CD tests found in the literature are very time consuming and need an extensive interviewer training. Most of these tests were also developed in high income countries, so they are not appropriate for use in the LMICs (38). In this context, where these surveys are the main source of reliable information, having an indicator to track child's development is extremely valuable, even if it is not the best one.

Also, for the analysis of the association of WE and CD, it will be required especial attention to the potential confounders as some of them can be included in the WE index (e. g. mother's education). This must be further discussed whit the advance in the indicator development and considering the conceptual model of this relation.

13 Ethical considerations

This research project works specifically with survey data, for which the ethical responsibility is entirely of the institutions that conducted them in each country. The respondent's confidentiality is preserved as all DHS and MICS data are anonymous. Also, all the surveys have already been approved by each country's local ethical committee, which eliminates the requirement of this project's ethical approval.

14 Chronogram of activities

The activities will follow the chronogram presented in Table 10, below. We expect the thesis defense to be held in the beginning of the second quarter of 2018, achieving all the objectives in approximately 38 months.

Table 10. Chronogram of activities

Year	2015				2016				2017				2018	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Activities														
ICEH ¹ activities														
Literature Review														
PhD Work Planning														
Data analysis – paper 12														
Paper 1 writing ²														
Literature systematic review														
Paper 2 writing ³														
Data analysis – paper 3														
Paper 3 writing ⁴														
Thesis defense														

Notes: ¹ International Center for Equity in Health;

² Paper 1 – Development of the WE indicator;

³ Paper 2 – Literature review on the existent survey-based WE indicators;

⁴ Paper 3 – Association among WE and child development

15 Results dissemination

The main results of the thesis will be presented in scientific events and published in indexed academic journals that we consider appropriate for the papers. In addition, these results will be sent to the press to communicate the community about the findings.

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Project adjustments along the course of the work

Project adjustments

In the original project presented we had planned a literature review article on the measurable aspects of women's empowerment and the existing survey-based indicators. However, for the PhD project and for the first article of the thesis, in which we developed a women's empowerment index based on survey data, the existing empowerment indicators available were identified. There was not enough literature on survey-based indicators of empowerment to justify a review article. The proposed indicators were mostly country specific, ad hoc combination of empowerment related variables without an underlying theory, and therefore we thought such a literature review was not warranted. The alternative would be a more general review article on women's empowerment indicators and their conceptualization. However, reviewing women's empowerment more conceptually goes beyond the scope of the thesis and is not justified in view of an extensive recent review done by the KIT Gender group, based at the Royal Tropical Institute, Amsterdam, led by Anouka van Eerdewijk (2017). This review was commissioned by the Bill & Melinda Gates Foundation, and we had the opportunity to collaborate with the work.

Based on these arguments, we submitted a request to the board of the Postgraduate Program in Epidemiology, proposing to replace the review article with another original analytical article on the effect of women's empowerment on health intervention coverage, entitled "Does women's empowerment increase coverage of RMNCH interventions in Africa? An analysis using a survey-based empowerment indicator, the SWPER".

Reference

Anouka van Eerdewijk, Franz Wong, Chloe Vaast, *et al* (2017). White Paper: A Conceptual Model of Women and Girls' Empowerment. Amsterdam: Royal Tropical Institute (KIT).

Fieldwork

Fieldwork

It is stated that all thesis produced at the Postgraduate Program in Epidemiology from the Universidade Federal de Pelotas present a section about the student fieldwork experience during the PhD. However, the students based in the International Center for Equity in Health (ICEH) have a different routine, working with the analyses of secondary data. Thus, instead of presenting the fieldwork experience, this section will rely on the activities I was involved in the ICEH during this period.

International Center for Equity in Health

The ICEH mission is to monitor inequalities in health, focusing in maternal and child health in low- and middle-income settings. The ICEH was created by a team of researchers from the Universidade Federal de Pelotas known for their wide experience in equity research. The Center provides relevant data to the WHO's Global Health Observatory Health Equity Monitor and the Countdown to 2030 Initiative for monitoring health equity in low- and middle-income countries¹.

Among the main activities of the ICEH is the analyses of relevant data sources, particularly Demographic and Health Surveys and Multiple Indicator Cluster Surveys, to generate a standardized set of indicators and assess the inequalities related to them. By standard, the analyses are stratified by wealth, geographic region and area (urban/rural) of residence, education level, age and sex. The analyses are done periodically as new survey data is released.

The ICEH team is subdivided into four main groups, that are responsible for the analyses of a set of related indicators: (1) fertility and mortality; (2) Maternal, Newborn and Child health; (3) Nutrition; and (4) Reproductive health, Sanitation and Malaria. During my PhD period, I have worked initially with the Maternal, Newborn and Child health group. Later on, I was relocated to the Reproductive health, Sanitation and Malaria group, which currently also comprises a set of indicators related to the women, as partner violence, ever experience of sexual violence and female genital mutilation/cutting. The analyses routine included writing

¹ Available from <<http://equidade.org/home>>.

and checking the codes, running the analyses, checking whether the national estimate was consistent with the published estimates and, when there was an inconsistency, identifying the reason for the differences.

Specific tasks

Besides the analyses routine, the ICEH also has diverse projects with specific analyses being produced for different organizations. The first article of my PhD was directly related to a Project funded by the Bill and Melinda Gates Foundation (BMGF), so I was one of the main researchers working in all phases of this project. The first phase of the project relied on the development of an indicator to measure women's empowerment based on survey data. This analysis resulted in the development of the SWPER Index (presented in detail in the next section of the thesis). To develop this indicator, we participated to meetings promoted by the BMGF, where we had the opportunity to discuss its methods and rationale with experts in gender empowerment from different countries:

Putting women and girls at the center of development: sharing and exchange meeting (January 2016 in Delhi, India)

In this first meeting we had the opportunity to learn more about the programs and interventions being funded by the BMGF to improve the women's situation and reduce gender inequalities both globally and in India.

Putting women and girls at the center of development Grand Challenge: measurement and evaluation workshop (February 2016 in Nairobi, Kenya)

This meeting aimed at inspiring innovative thinking and building collective capacity on measurement and evaluation approaches, focusing on gender equality and empowerment of women and girls. In this opportunity, we participated in a panel discussion and we also presented preliminary results of the development of the SWPER index. The panel discussion was on innovative approaches for measuring empowerment of women and girls and we already had the opportunity to discuss the SWPER rationale with experts having Professor Aluísio Barros as one of the panelists. The preliminary results were then presented in another session, that aimed at providing an overview of three different empowerment measures, which was a great opportunity to discuss the analyses.

Royal Tropical Institute (KIT) gender group meeting (September 2016 in Amsterdam, Netherlands)

The KIT gender group was commissioning an extensive literature review on women's empowerment, and their group had a wide theoretical knowledge in the field. Thus, we invited Anouka van Eerdewijk and Marcelo Tyszler to contribute to the paper on the development of the SWPER as co-authors. In this meeting we had the opportunity to discuss the final analyses of the paper with their whole group and we also worked together to finalize the paper draft.

The second and third phases of the BMGF project involved analyses on family planning. In the second phase we put an equity lens on that to indicate the groups that were lagging in terms of demand for family planning satisfied, focusing on modern contraceptive methods. The academic paper resulting from these analyses is titled "Demand for family planning satisfied with modern methods among sexually active women in low- and middle-income countries: who is lagging behind?" and was published at the BMC Reproductive Health in March 2018. In the third phase we evaluated time trends in demand for family planning satisfied. This paper was led by Franciele Hellwig and is currently under review at the BMJ Global Health.

In 2017/2018 I also got involved in another project related to family planning commissioned to the Centro Latinoamericano de Perinatología, Salud de la Mujer y Reproductiva (CLAP/SRM). The objective of this project was to evaluate the contraceptive use and the demand for family planning satisfied in Latin America and the Caribbean, focusing on long acting reversible contraceptive methods. It is still currently in progress.

[Sandwich PhD at the University of Adelaide, Australia](#)

From March 2017 to January 2018 I was based in Adelaide, Australia, working with Professor John Lynch who is a lead researcher in epidemiology, public health and health inequalities. Professor John Lynch also coordinates the BetterStart group, whose main objectives are "to build evidence to improve the health and development of the children". This period was very important to advance on the analyses for the third paper of my thesis, in which we evaluated the effect of the mothers' empowerment level on the development of the child. Professor John and Dr. Murthy Mittinty, the BetterStart group statistician, had an important participation in the development of the paper. In this period, I also had the opportunity to

experience the BetterStart group work, participating in their weekly research meetings and performing some exploratory analyses with their databases.

Article 1

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The SWPER index for women's empowerment in Africa: development and validation of an index based on survey data



Fernanda Ewerling, John W Lynch, Cesar G Victora, Anouka van Eerdegwijk, Marcelo Tyszler, Aluisio J D Barros



Summary

Background The Sustainable Development Goals strongly focus on equity. Goal 5 explicitly aims to empower all women and girls, reinforcing the need to have a reliable indicator to track progress. Our objective was to develop a novel women's empowerment indicator from widely available data sources, broadening opportunities for monitoring and research on women's empowerment.

Methods We used Demographic and Health Survey data from 34 African countries, targeting currently partnered women. We identified items related to women's empowerment present in most surveys, and used principal component analysis to extract the components. We carried out a convergent validation process using coverage of three health interventions as outcomes; and an external validation process by analysing correlations with the Gender Development Index.

Findings 15 items related to women's empowerment were selected. We retained three components (50% of total variation) which, after rotation, were identified as three dimensions of empowerment: attitude to violence, social independence, and decision making. All dimensions had moderate to high correlation with the Gender Development Index. Social independence was associated with higher coverage of maternal and child interventions; attitude to violence and decision making were more consistently associated with the use of modern contraception.

Interpretation The index, named Survey-based Women's emPOWERment index (SWPER), has potential to widen the research on women's empowerment and to give a better estimate of its effect on health interventions and outcomes. It allows within-country and between-country comparison, as well as time trend analysis, which no other survey-based index provides.

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Introduction

With the call to "leave no one behind", the Sustainable Development Goals (SDGs) were launched last year by the UN. Gender equity has been specified in many of the SDGs, and goal 5 explicitly aims at the achievement of gender equality and the empowerment of all women and girls.

Women's empowerment is a complex concept for which several definitions exist. The World Bank defines empowerment as "the process of enhancing an individual's or group's capacity to make purposive choices and to transform those choices into desired actions and outcomes".¹ Empowerment for women only happens when they can envisage a different life and consider themselves able and entitled to make decisions.² It involves the development of a critical consciousness of women's rights and of gendered power relations, and how these can be changed, so that gender inequity can be overcome.³ Empowering women and girls is a goal in itself, as well as a promoter of development.¹

More empowered women are more likely to use modern contraception, have access to antenatal care and skilled birth attendance, and to provide their children with appropriate nutrition.⁴⁻⁷ Over the past 20 years, progress

has been made on gender equity, but slowly. Progress has also been uneven, with large differences between and within countries, and in different wealth groups.⁸⁻¹¹

Women's empowerment is difficult to measure because of its abstract and comprehensive nature.¹² There is consensus that empowerment is multidimensional and is expressed at multiple levels, but less agreement on which dimensions and levels matter more. Some indices have been proposed for low-income and middle-income countries using the Demographic and Health Surveys (DHS),^{4,6,13-20} which have included an empowerment module since 1999.³ These indices are essentially based on the DHS empowerment module, which includes questions on the woman's involvement in household decisions; employment and type of earnings; control over resources; opinion on wife-beating; and personal ownership of a house or land. These indices have three major limitations: first, the weightings used for the items were chosen subjectively; second, they are only applied to married women because most questions related to empowerment are restricted to this group; and third, they were designed for specific countries or small groups of countries, preventing wider comparisons across countries. The DHS country reports also present two empowerment indices, one composed of

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Research in context

Evidence before this study

The most widely used gender equality indicators, such as the Gender Development Index, are calculated at the country level. In order to include gender in equity analyses, especially for low-income and middle-income countries, an indicator of women's empowerment is needed that can be calculated from national surveys. We searched PubMed, POPLINE, and Google using the terms ((("women"[MeSH Terms] OR "woman"[All Fields]) AND ("power (psychology)"[MeSH Terms] OR ("empowerment"[All Fields])). Most of what we found was from the USAID website, where the Demographic and Health Survey reports are published. We selected publications on the development of novel women's empowerment indicators and those that analysed the association between women's empowerment and reproductive, maternal, and child health outcomes. The indicators we found came mainly from reports that based their analyses on specific countries or surveys. The indicators were usually based on information selected and grouped arbitrarily, and weights to items were defined without any clear strategy.

Added value of this study

We propose an indicator (SWPER), which encompasses three well recognised domains of women's empowerment (attitude to violence, social independence, and decision making). The SWPER enables within-country and between-country comparisons, as well as time trend analyses for African countries. No other index has these features. Additionally, it can be calculated at the individual level, enabling detailed analyses to be done of empowerment as an outcome or as a determinant of health.

Implications of all the available evidence

Our index enables new studies that were not previously possible. The Sustainable Development Goals put equity high on the agenda, strongly emphasising gender equity. The SWPER is a powerful tool for gender analysis in a region where women's empowerment and gender equity are important issues, and most of the available data come from national surveys.

decision-making questions and another based on the number of reasons for which the woman thinks wife-beating is justified. Again, these indices are subjectively weighted and are not strictly comparable because not all questions are available in all surveys, and different questions are considered in the indices.

Several group-level indicators have also been proposed, which condense national or regional information and are generally presented at the country level, for example the Gender Gap Index,²¹ the Gender Development Index, and the Gender Inequality Index.¹⁰ These indices provide rankings of the countries according to the extent to which women have achieved equality with men. However, they do not enable subnational analyses or subgroup comparisons.

Having a specific SDG on this topic reinforces its importance and the need for a cross-cultural standard indicator to track women's empowerment at different levels to guarantee that the most vulnerable groups are not being left behind and to hold governments and policy makers accountable.²² Formulating such an index is a great challenge given the different cultures across countries, since a valid cross-country indicator requires the identification of universally recognised measures of women's empowerment.¹³ We aimed to develop an indicator of empowerment on the basis of individual-level DHS data for African countries that enables comparability between countries and over time. We then aimed to assess how countries compared on this indicator, and to assess the validity of the indicator through its association with key maternal and child health indicators and its correlation with another empowerment indicator.

Methods

We used data from DHS, which are highly comparable and nationally representative. DHS are one of the main publicly available sources of information for low-income and middle-income countries. Given their focus on maternal and reproductive health, these surveys target women aged 15–49 years. We selected Africa because 37 of the 54 African countries have conducted at least one DHS. Some African countries have the lowest levels of gender equality,^{10,21} poverty levels are high, and there is a unique mix of religions and ethnicity. We used the latest survey available for each country. The ethical responsibility for the DHS lies with the institutions that conducted the surveys in each country; we therefore did not require ethics approval for this study.

We identified questions relevant to women's empowerment that were available in most surveys. Those that were not available in most surveys, at least for partnered women, were discarded. We recoded the answers to the selected questions so that a higher value was given to categories considered to indicate greater empowerment. One of the selected items was age at first birth. Since 5–10% of women had no children at the time of the survey, we imputed data for these cases through single hot-deck imputation, clustering women in groups of age at first cohabitation (appendix). Because several of the relevant items were asked only to women in a union, we restricted our analyses to this group.

We excluded three countries (South Africa, Central African Republic, and the Republic of Congo) because their surveys did not include all the selected items. Thus, 34 countries remained, with surveys from 2003 to 2014. The appendix shows the complete list of surveys (p 1).

See Online for appendix

Initially, we did principal component analysis in each of the 34 surveys and checked the results (components and items' loadings) for consistency across surveys. We analysed scree plots to define the number of components to be retained and applied orthogonal varimax rotation to the retained components. Next, to achieve a common index that would enable assessment of time trends and cross-country comparisons, we used an approach similar to the development of the International Wealth Index,²³ performing the principal component analysis on a combined dataset to derive a single indicator of empowerment applicable to all countries.

After creating the index, we assessed its external validity through its correlation with the Gender Development Index, a widely used indicator of gender equality that measures the gender gaps in human development achievements in health, education, and income.¹⁰ The correlation was measured at country level.

More empowered women usually have higher use of health services, and can provide better feeding and care to their children.^{4-6,16,24,25} Thus, we assessed the association between our empowerment index and use of modern contraceptives, institutional delivery, and the prevalence of stunting for the women's last born child to evaluate the convergent validity of the index. We estimated these associations using Poisson regression.²⁶ We adjusted all analyses for household wealth. We do not imply that wealth causes empowerment, or the reverse. Because the outcomes are all strongly associated with wealth, by adjusting the analyses we aimed to evaluate whether there was an association of empowerment with the three outcomes independent of wealth. We did the analyses using Stata (release 13).

Role of the funding source

The funder had no role in the data analysis, data interpretation, or writing of the paper. The corresponding author had full access to all the data and had final responsibility for the decision to submit for publication.

Results

Initially, we identified 23 items as candidates for our analyses; after checking availability and further theoretical assessment some were excluded (appendix p 1). In the end, we considered 15 items relevant for the index (available in 34 of the 37 surveys), of which five were related to the women's opinion on whether wife-beating was justified in specific situations, and three were related to involvement in household decisions. The other items included the frequency of reading a newspaper or magazine, the woman's education and working status in the previous year, differences in education and age between wife and husband, and the woman's age at first cohabitation and at first birth. Table 1 presents the selected items, and how they were coded.

Scree plots showed an abrupt flattening of the curve (slower reduction in the eigenvalues) after the third

	Code or unit
Beating not justified if wife goes out without telling husband	Justified=-1; don't know=0; not justified =1
Beating not justified if wife neglects the children	Justified=-1; don't know=0; not justified=1
Beating not justified if wife argues with husband	Justified=-1; don't know=0; not justified=1
Beating not justified if wife refuses to have sex with husband	Justified=-1; don't know=0; not justified=1
Beating not justified if wife burns the food	Justified=-1; don't know=0; not justified=1
Frequency of reading newspaper or magazine	Not at all=0; <once a week=1; ≥once a week=2
Respondent worked in past 12 months	No=0; in the past year=1; have a job, but on leave past 7 days=2; currently working=2
Woman's education in completed years of schooling	Years
Education difference: woman's minus husband's completed years of schooling	Years
Age difference: woman's age minus husband's age	Years
Age at first cohabitation	Years
Age of woman at first birth*	Years
Who usually decides on respondent's health care	Husband or other alone=-1; joint=0; respondent alone=1
Who usually decides on large household purchases	Husband or other alone=-1; joint=0; respondent alone=1
Who usually decides on visits to family or relatives	Husband or other alone=-1; joint=0; respondent alone=1

*Imputed for women who had not had a child.

Table 1: Items used in the development of the survey-based women's empowerment index

	Attitude to violence	Social independence	Decision making
Beating not justified if wife goes out without telling husband	0.4562	-0.0054	-0.0006
Beating not justified if wife neglects the children	0.4671	-0.0193	-0.0380
Beating not justified if wife argues with husband	0.4594	0.0004	0.0066
Beating not justified if wife refuses to have sex with husband	0.4364	-0.0003	0.0229
Beating not justified if wife burns the food	0.4044	-0.0019	-0.0107
Frequency of reading newspaper or magazine	0.0332	0.3258	0.0891
Woman's education in completed years of schooling	0.0715	0.4178	0.1197
Age of woman at first birth	-0.0335	0.5610	-0.0772
Age at first cohabitation	-0.0155	0.5696	-0.0264
Age difference: woman's age minus husband's age	0.0123	0.1933	0.0931
Education difference: woman's minus husband's years of schooling	-0.0171	0.1943	-0.0348
Who usually decides on respondent's health care	0.0057	0.0028	0.5634
Who usually decides on large household purchases	-0.0229	-0.0087	0.5646
Who usually decides on visits to family or relatives	0.0056	-0.0365	0.5423
Respondent worked in past 12 months	-0.0012	-0.0564	0.1698

Table 2: Principal component analysis factor loadings, based on the combined dataset including all African countries (n=280 209)

component for 30 of the 34 countries. Thus, we retained three components in all surveys and proceeded with varimax rotation. The results for all surveys were similar regarding the composition of the components extracted and the item loadings in each component. The appendix (p 3) shows clusters of items with loadings of 0.3 or more. In Cameroon, Gabon, and Lesotho the scree plots suggested retaining two components, and in Mali, four.

We assessed the convergent validity of the SWPER at the individual level, through its association with modern contraceptive use, institutional delivery, and stunting (figure 3). We estimated the prevalence ratio by comparing the coverage in the top quintile of empowerment (Q5) with the bottom quintile (Q1), both crude and adjusted by wealth. Figures are presented in log scale, so that we have symmetry between preventive and risk effects.

Attitude to violence and decision making were more consistently associated with modern contraceptive use than with social independence. 20 of the 34 countries presented positive and statistically significant adjusted effects when we analysed the decision-making domain. In 14 countries, we did not find an association. The strongest association was in Nigeria, where the most empowered women were 8.6 times more likely to use modern contraception.

Social independence was more consistently associated with institutional delivery and stunting than the other domains. 27 of 34 countries had a positive and statistically significant effect with institutional delivery after adjustment by wealth. The strongest effect was again in Nigeria, where the most empowered women were 2.6 times more likely to have had an institutional delivery. Regarding stunting, we found a protective effect of social independence in 25 countries. However, after adjustment, only seven countries showed a statistically significant association, with reductions of up to 44% in stunting prevalence comparing the top and bottom quintiles of empowerment in Swaziland.

Discussion

The SDGs put gender equity and empowerment of women and girls high on the agenda, reflecting the need to improve opportunities for women²² in order to advance social development by closing the gender gap.^{27–29} Creating a women's empowerment indicator that can be used in low-income and middle-income countries—where reliable data are scarce—is an important step in this direction.

Although few questions in DHS are related to empowerment, various indicators are based on DHS data.^{4–6,11–20} Principal component analysis was used in some of these indicators.^{4,18,19} However, all these measures were proposed to assess women's empowerment in specific contexts and include many items that are not available in all surveys. Our results showed that the data-driven empowerment domains were consistent across African countries, despite contextual differences within the continent. The greatest advantage of SWPER compared with previously proposed indicators is that it can be used across all African countries, allowing comparisons between countries and population subgroups, which are needed to properly analyse equity. It also enables analyses of time trends, which will help track the achievements of

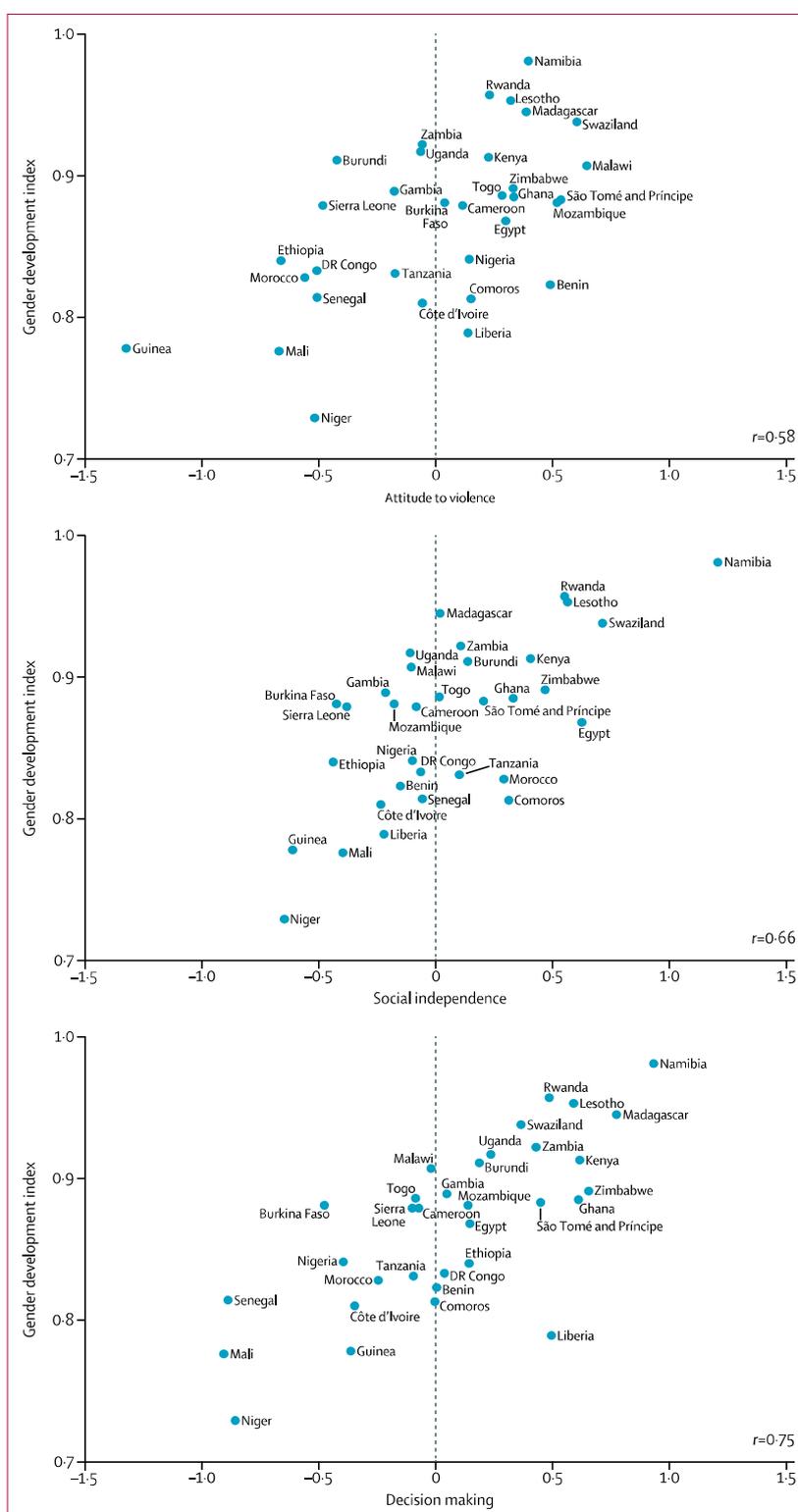
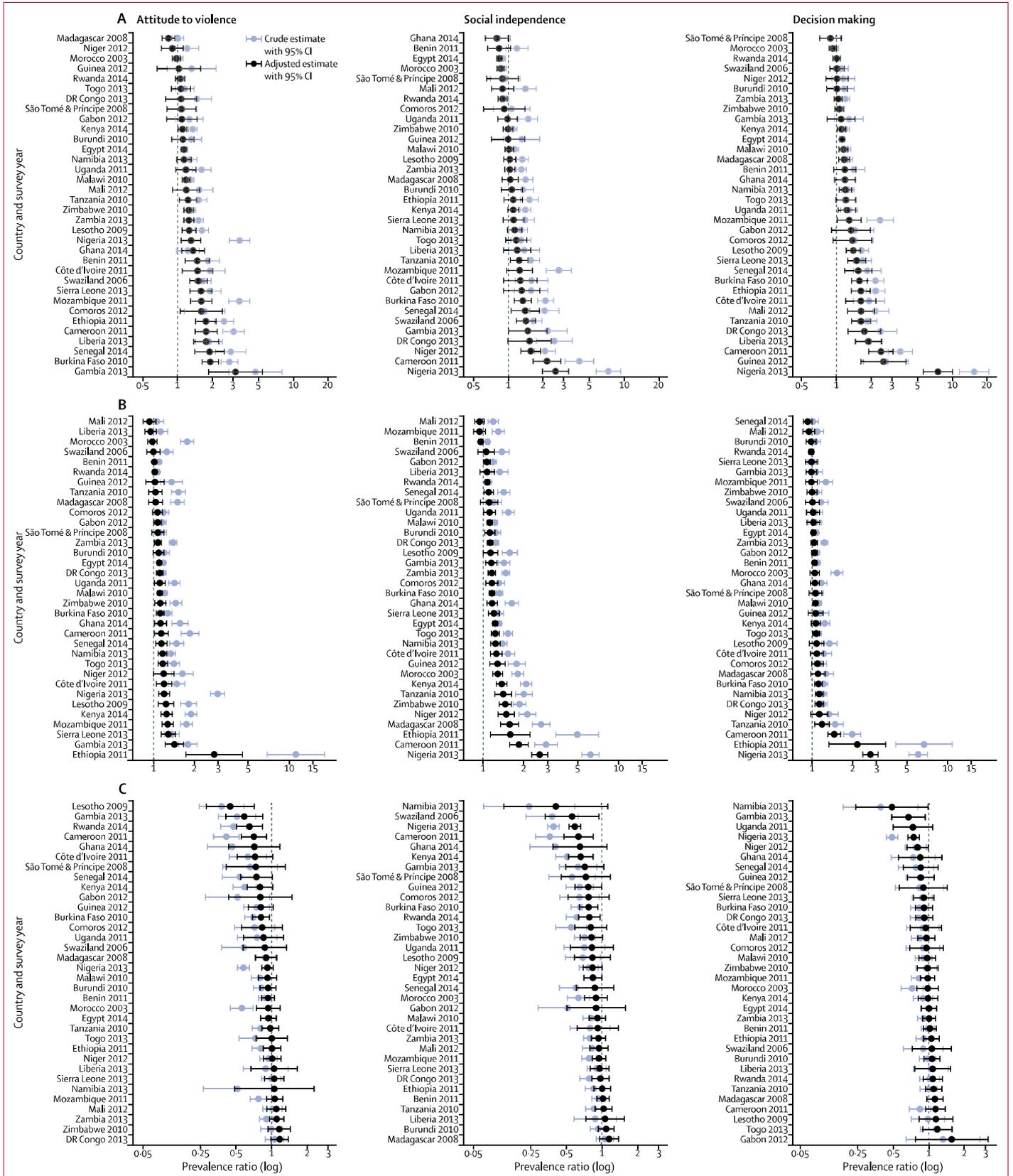


Figure 2: Correlation between the SWPER domains and the Gender Development Index

women in different subgroups, regions, or countries towards goal 5 of the SDGs. For the Stata do-file see <https://goo.gl/isGonn>



The correlations between the SWPER domains and the Gender Development Index were high. These results suggest that our index measures relevant aspects of women's empowerment. The SWPER is a useful addition to the Gender Development Index because it can be applied at both the ecological level, as can the Gender Development Index, and at the individual level. Empowerment of women and girls is a goal in itself and promotes development, including economic growth, reduction of poverty, and the accomplishment of human rights.¹ Empowerment of women and girls could also affect changes in families by providing women with greater autonomy and participation in decision making. We showed that social independence was more consistently related to institutional delivery, and that the attitude to violence and decision-making domains seemed to have a more consistent pattern and greater effect on use of modern contraception. These results accord with studies⁴⁻⁶ showing that women's empowerment is positively associated with diverse health outcomes and interventions including modern contraceptive use and access to maternal interventions such as antenatal care and skilled birth attendance. Women's empowerment is also associated with the desire for fewer children, although this finding is not consistent across sub-Saharan Africa. This lack of consistency, found in our study and also previous work, could be related to different cultural norms: in some countries, large families are expected by society.¹³ It is a common assumption in multicountry studies that the relation between women's empowerment and outcomes will be different for each setting.¹⁸

Gender equality also has a central role in children's health.³⁰ Findings from a study¹⁶ done in sub-Saharan Africa and south Asia showed that the more women controlled the economic resources in the household, the more money was spent on their children. Thus, more empowered women would also be more likely to provide their children with appropriate care and nutrition, improving their chances to survive and properly develop.²⁵ We found that social independence was more consistently associated with stunting, but the effect disappeared for most countries after adjustment.

We adjusted the associations by wealth to evaluate whether it could explain the associations between empowerment and the three outcomes that are themselves strongly associated with wealth. For use of modern contraception and institutional delivery, the adjusted effect sizes were lower than the crude effect sizes; however, generally they remained statistically significant. Thus, the effects are not explained only by

wealth, but also by women's empowerment itself. Further work is needed to assess possible confounders for these associations.

The major limitation of SWPER is that most of the relevant questions were only applied to partnered women. On average, 34% of the women in our dataset were not in a union, ranging from 62% in Namibia (where empowerment levels were high) to only 6% in Egypt. Many empowered women are not necessarily married or will marry later in life. Disabled women and sex workers, who are among the most marginalised and disempowered, might be less likely to be married, and, thus, they are not included in the index. Likewise, our results cannot be generalised to adolescents, many of whom are unmarried. The indicator's scope is also limited by the fact that data from DHS do not cover all aspects of empowerment. For example, they include little on economic and political participation and leadership of women, or on rights to resources and other forms of discrimination against women. Finally, northern and central Africa are to some extent under-represented in our analyses because there were no available data for many countries in these regions.

The age at first birth was considered an important indicator of empowerment, so we included it even though we had to impute data for women who did not have any child by the time of the survey. In most surveys, 5–10% of women had not had a child. These women were generally very young, and did not have enough time to get pregnant after marriage.

Women's empowerment and gender equality might take different forms in different countries across Africa. Yet, the dimensions of empowerment and the correlation structure we identified were very similar across countries, albeit with widely varying scores. The scores from our index must be interpreted in the light of each country's specific context. As a next step, we are exploring the use of this method with surveys in Asia in an attempt to widen the availability of a survey-based empowerment index.

Given the increasing concerns about gender equity, we urge health surveys—one of the main sources of reliable information in low-income and middle-income countries—to incorporate more questions related to empowerment. The DHS already includes a set of questions, but these should be expanded to ensure broader and deeper coverage of issues related to SDG 5. Our proposed empowerment index would also benefit from additional questions on violence against women, social independence, and decision making within the household, to strengthen each of the three key factors. We expect that with the increasing use of these data for estimating women's empowerment, the number of such variables will increase because understanding these issues with maximum representation is crucial. Intervals between DHS are not regular, varying largely across countries. New survey platforms administered more

Figure 3: Association between modern contraceptive use (A), institutional delivery (B), stunting prevalence (C), and the SWPER domains
Coefficients are prevalence ratios comparing the fifth quintile of empowerment (most empowered) versus the first quintile (least empowered). Crude and household wealth-adjusted results are shown.

frequently, such as PMA2020, might also include information on women's empowerment, enabling advances towards SDG 5 to be tracked.

SWPER has great potential to widen research on women's empowerment by enabling studies that were not previously possible. The SWPER index enables within-country and between-country comparisons, as well as analysis of time trends, which no other indicator offers. Thus, by improving the comparability of results, we expect SWPER to give a better estimate of the inequalities and its effects of empowerment on maternal, reproductive, and child health.

Contributors

FE did the analysis and wrote the first draft of the Article. JWL, AvE, MT, and CGV wrote and revised the Article. AJDB designed the study and wrote and revised the Article. All authors read and approved the final manuscript.

Declaration of interests

We declare no competing interests.

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The SWPER index for women's empowerment in Africa: development and validation of an index based on survey data

Ewerling, F et al. The Lancet Global Health, 2017.

Supplementary tables and figures

Table S1. Latest DHS surveys from African countries included in the analyses and number of women in the samples.

Country	Year	N	Country	Year	N
1. Benin	2011	11206	18. Malawi	2010	15067
2. Burkina Faso	2010	13192	19. Mali	2012	8737
3. Burundi	2010	5138	20. Morocco	2003	8619
4. Cameroon	2011	9039	21. Mozambique	2011	8643
5. Comoros	2012	2930	22. Namibia	2013	3520
6. Congo DR	2013	12045	23. Niger	2012	9165
7. Côte d'Ivoire	2011	5817	24. Nigeria	2013	26500
8. Egypt	2014	20406	25. Rwanda	2014	6778
9. Ethiopia	2011	10004	26. S Tomé & Príncipe	2008	1715
10. Gabon	2012	4100	27. Senegal	2014	5251
11. Gambia	2013	6423	28. Sierra Leone	2013	10254
12. Ghana	2014	5343	29. Swaziland	2006	1888
13. Guinea	2012	6641	30. Tanzania	2010	6233
14. Kenya	2014	8833	31. Togo	2013	6161
15. Lesotho	2009	4069	32. Uganda	2011	5150
16. Liberia	2013	5708	33. Zambia	2013	9088
17. Madagascar	2008	11102	34. Zimbabwe	2010	5444

Table S2. DHS variables included in the empowerment index and reasons for exclusion.

Variable	Included	Reason for exclusion
Beating justified if wife goes out without telling husband	Yes	
Beating justified if wife neglects the children	Yes	
Beating justified if wife argues with husband	Yes	
Beating justified if wife refuses to have sex with husband	Yes	
Beating justified if wife burns the food	Yes	
Frequency of reading newspaper or magazine	Yes	
Respondent worked in last 12 months	Yes	
Woman's education	Yes	
Education difference: woman's minus husband's years of schooling	Yes	
Age difference: woman's minus husband's age	Yes	
Age at first cohabitation	Yes	
Age of respondent at 1st birth	Yes	
Who usually decides on respondent's health care	Yes	
Who usually decides on large household purchases	Yes	
Who usually decides on visits to family or relatives	Yes	
Who usually decides on daily household purchases	No	Not available in all surveys
Whether she can refuse to have sex with the husband	No	Not available in all surveys
Ever used anything or tried to delay or avoid getting pregnant	No	Not available in all surveys
Type of earnings from respondent's work	No	Asked only to women employed in last year
Can you go to a health centre or hospital alone or with your young children?	No	Not available in all surveys
Decision maker for using contraception	No	Asked only to women using contraception
Ownership of house or land	No	Not available in all surveys
Ownership of a personal mobile phone	No	Usually a household question; personal information is not available in all surveys.

Table S3. Composition patterns of the SWPER domains.

Country	N	Variable numbers*															
		Attitude to violence					Social independence					Decision making					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	11	6
Benin	11206	x	x	x	x	x	x	x	x	x		x	x	x			
Burkina Faso	13192	x	x	x	x	x	x	x	x	x		x	x	x			
Burundi	5138	x	x	x	x	x	x	x	x	x		x	x	x			
Cameroon	9039	x	x	x	x	x	x	x	x	x		x	x	x		x	
Comoros	2930	x	x	x	x	x	x	x	x	x		x	x	x			
Côte d'Ivoire	12045	x	x	x	x	x	x	x	x	x		x	x	x			
Gambia	5817	x	x	x	x	x	x	x	x	x		x	x	x			
Ghana	20406	x	x	x	x	x	x	x	x	x		x	x	x			
Guinea	10004	x	x	x	x	x	x	x	x	x		x	x	x			
Kenya	4100	x	x	x	x	x	x	x	x	x		x	x	x		x	
Madagascar	6423	x	x	x	x	x	x	x	x	x		x	x	x			
Mali	5343	x	x	x	x	x	x	x	x	x		x	x	x			
Niger	6641	x	x	x	x	x	x	x	x	x		x	x	x			
Nigeria	8833	x	x	x	x	x	x	x	x	x		x	x	x		x	
Senegal	4069	x	x	x	x	x	x	x	x	x		x	x	x		x	
Sierra Leone	5708	x	x	x	x	x	x	x	x	x		x	x	x			
Swaziland	11102	x	x	x	x	x	x	x	x	x		x	x	x			
Togo	15067	x	x	x	x	x	x	x	x	x		x	x	x		x	
Uganda	8737	x	x	x	x	x	x	x	x	x		x	x	x			
Zambia	8619	x	x	x	x	x	x	x	x	x		x	x	x			
Zimbabwe	8643	x	x	x	x	x	x	x	x	x		x	x	x			
Congo DR	3520	x	x	x	x	x	x	x	x	x		x	x	x			
Gabon	9165	x	x	x	x	x	x	x	x	x		x	x	x			
Liberia	26500	x	x	x	x	x	x	x	x	x		x	x	x			
S Tomé & Príncipe	6685	x	x	x	x	x	x	x	x	x		x	x	x			
Egypt	1715	x	x	x	x	x	x	x	x	x		x	x	x			
Ethiopia	5251	x	x	x	x	x	x	x	x	x		x	x	x			
Lesotho	10254	x	x	x	x	x	x	x	x	x		x	x	x			
Malawi	1888	x	x	x	x	x	x	x	x	x		x	x	x			
Morocco	6233	x	x	x	x	x	x	x	x	x		x	x	x			
Rwanda	6778	x	x	x	x	x	x	x	x	x		x	x	x			
Mozambique	5150	x	x	x	x	x		x	x			x	x	x		x	x
Tanzania	9088	x	x	x	x	x		x	x	x		x	x	x			
Namibia	5444	x	x	x	x	x	x	x	x	x		x	x	x			

Key to variable numbers: Beating not justified: (1) if woman goes out without telling husband; (2) if woman neglects the children; (3) if woman argues with husband; (4) if woman refuses to have sex with husband; (5) if woman burns the food; (6) Frequency of reading newspaper; (7) Education; (8) Age at 1st birth; (9) Age at 1st cohabitation; (10) Education difference (woman's minus husband's years of schooling); (11) Work; Who usually decides on: (12) respondent's healthcare; (13) large household purchases; (14) visits to family or relatives.

Table S4. Tertiles (green=top; yellow=intermediate; red=bottom) and country rankings of the average national scores of the three domains. Top tertile represent the countries with higher average empowerment levels.

Country	Year	Tertiles			Ranking		
		Attitude to violence	Social Independence	Decision making	Attitude to violence	Social Independence	Decision making
Namibia	2013	3	3	3	6	1	1
Lesotho	2009	3	3	3	10	5	7
Zimbabwe	2010	3	3	3	9	7	3
Ghana	2014	3	3	3	8	9	6
Swaziland	2006	3	3	2	2	2	12
Egypt	2014	3	3	2	11	3	15
Gabon	2012	2	3	3	15	4	4
Rwanda	2014	2	3	3	13	6	9
Kenya	2014	2	3	3	14	8	5
S Tomé & Príncipe	2008	3	2	3	3	12	10
Madagascar	2008	3	2	3	7	16	2
Comoros	2012	2	3	2	16	10	21
Zambia	2013	2	2	3	22	14	11
Malawi	2010	3	2	2	1	22	22
Benin	2011	3	1	2	5	24	20
Mozambique	2011	3	1	2	4	25	17
Liberia	2013	2	1	3	18	27	8
Morocco	2003	1	3	1	31	11	27
Burundi	2010	1	2	2	26	13	14
Togo	2013	2	2	1	12	17	24
Congo DR	2013	1	2	2	29	19	19
Cameroon	2011	2	2	1	19	20	23
Nigeria	2013	2	2	1	17	21	30
Tanzania	2010	1	2	1	24	15	25
Senegal	2014	1	2	1	28	18	33
Uganda	2011	1	1	2	23	23	13
Gambia	2013	1	1	2	25	26	18
Cote d'Ivoire	2011	2	1	1	21	28	28
Burkina Faso	2010	2	1	1	20	31	31
Ethiopia	2011	1	1	2	32	32	16
Sierra Leone	2013	1	1	1	27	29	26
Mali	2012	1	1	1	33	30	34
Guinea	2012	1	1	1	34	33	29
Niger	2012	1	1	1	30	34	32

How to calculate the SWPER for a specific survey

The equation used to estimate individual standardized scores for each of the PCA j components is given by:

$$S_{ij} = \frac{[\lambda_{1j}(x_{1i} - \bar{x}_1)] + [(\lambda_{2j}(x_{2i} - \bar{x}_2))] + \dots + [\lambda_{15j}(x_{15i} - \bar{x}_{15})]}{\sigma_j} \quad (1)$$

where S_{ij} are the individual standardized scores for individual i and component j ; x_{1j}, \dots, x_{15j} are the individual values for variables x_1 - x_{15} included in the PCA analyses; σ_j are the standard deviations of the predicted scores of each component j . The weight given to each of the 15 variables in each component j is defined as:

$$\lambda_{vj} = \frac{\varphi_{vj}}{\sigma_v} \quad (2)$$

Where φ_{vj} is the PCA loading for each of the variables v in each domain j and σ_v is the standard deviation of each variable v in the combined dataset.

By using simple algebra, we can simplify the equation above to:

$$S_{ij} = \frac{[-(\sum_{v=1}^{15} \lambda_{vj} \bar{x}_v) + \sum_{v=1}^{15} (\lambda_{vj} x_{vi})]}{\sigma_j} \quad (3)$$

Please, follow the next steps to calculate the standardized individual SWPER scores for any African country of your interest¹:

1. Recode variables

The first step is to recode the variables as it is shown in Table S5, below.

1.1. Imputation of woman's age at first birth

To proceed the imputation of age at first birth for nulliparous women, we used single hotdeck imputation. This method randomly selects the value to be imputed for a missing case from a group of individuals that are similar to it in terms of a variable or a group of variables. In this case, women were clustered in groups of age at first cohabitation. This variable was selected because it had the highest correlation with age at first birth, and other variables did not add much predictive power in a regression model. Despite the current preference for multiple imputation, we used a single imputation approach because procedures for principal component analysis with multiple imputation data are not commonly available, and the percentage of missing information was not so high that overall variance would be significantly reduced by use of single imputation.

2. Calculate the individual scores

Using the equations below, it is possible to estimate the scores for the three SWPER domains:

$$\begin{aligned} \text{Score}_{\text{Attitude to violence}_i} &= \frac{[-0.950 + \sum_{v=1}^{15} (\lambda_{v1} x_{vi})]}{1.818} \\ \text{Score}_{\text{Social independence}_i} &= \frac{[-5.360 + \sum_{v=1}^{15} (\lambda_{v2} x_{vi})]}{1.475} \\ \text{Score}_{\text{Decision making}_i} &= \frac{[0.857 + \sum_{v=1}^{15} (\lambda_{v3} x_{vi})]}{1.417} \end{aligned}$$

¹ A Stata do-file with all procedures required for the calculation of the SWPER Index scores is available from the link < <https://goo.gl/isGonn> >.

Table S5. Variables used in the development of the survey-based women’s empowerment index.

Variable	Code or unit
Beating justified if: 1. wife goes out without telling husband 2. wife neglects the children 3. wife argues with husband 4. wife refuses to have sex with husband 5. wife burns the food	Yes = -1; DK=0; No=1
6. Frequency of reading newspaper or magazine	Not at all=0; <once a week=1; ≥once a week=2
7. Respondent worked in last 12 months	No = 0; In the past year = 1; Have a job, but on leave last 7 days = 2; Currently working = 2
8. Woman education in completed years of schooling	Years
9. Education difference: woman’s minus husband’s years of schooling	Years
10. Age difference: woman’s minus husband’s age	Years
11. Age at first cohabitation	Years
12. Age of woman at first birth*	Years
Who usually decides on: 13. Respondent's health care 14. Large household purchases 15. Visits to family or relatives	Husband/other alone= -1; joint=0; respondent alone=1

* This variable was imputed for women who had not had a child, please see section 1.1 for details.

Where x_{vi} is the value of variables v for each individual i and $\lambda_{v1} - \lambda_{v3}$ are the variable weights, that can be found in Table S6.

Table S6. Variable weights used in the equations for estimating individual scores for each domain of the SWPER Index.

Variable (v)	λ_{v1} Attitude to violence	λ_{v2} Social independence	λ_{v3} Decision- making
1. Beating not justified if wife goes out without telling husband	0.489	-0.006	-0.001
2. Beating not justified if wife neglects the children	0.493	-0.020	-0.040
3. Beating not justified if wife argues with husband	0.501	0.000	0.007
4. Beating not justified if wife refuses to have sex with husband	0.493	0.000	0.026
5. Beating not justified if wife burns the food	0.546	-0.003	-0.014
6. Frequency of reading newspaper or magazine	0.056	0.549	0.150
7. Woman education	0.015	0.090	0.026
8. Age of respondent at first birth	-0.008	0.141	-0.019
9. Age at first cohabitation	-0.004	0.131	-0.006
10. Age difference: woman’s minus husband’s age	0.002	0.026	0.012
11. Education difference: woman’s minus husband’s years of schooling	-0.004	0.050	-0.009
12. Who usually decides on respondent's health care	0.008	0.004	0.770
13. Who usually decides on large household purchases	-0.034	-0.013	0.831
14. Who usually decides on visits to family or relatives	0.008	-0.052	0.768
15. Respondent worked in last 12 months	-0.001	-0.060	0.180

```
*****
***** Code to estimate SWPER individual scores for each domain*****
*****
```

Written by Fernanda Ewerling

```
/*
```

```
READ ME
```

```
This do-file should be used only for African countries.
```

```
Before using this code, please make sure that your dataset has all the variables, with the same names presented below:
```

```
v744a - beat1 - Beating not justified if wife goes out without telling husband
```

```
v744b - beat2 - Beating not justified if wife neglects the children
```

```
v744c - beat3 - Beating not justified if wife argues with husband
```

```
v744d - beat4 - Beating not justified if wife refuses to have sex with husband
```

```
v744e - beat5 - Beating not justified if wife burns the food
```

```
v157 - read - Frequency of reading newspaper or magazine
```

```
v133 - educ - Woman education
```

```
v212 - age1birth - Age of respondent at first birth
```

```
v511 - age1cohab - Age at first cohabitation
```

```
v743a - decide1 - Who usually decides on respondent's health care
```

```
v743b - decide2 - Who usually decides on large household purchases
```

```
v743d - decide3 - Who usually decides on visits to family or relatives
```

```
v731 - work - Respondent worked in last 12 months
```

```
v715 - husb_educ - Husband's years of schooling
```

```
v730 - husb_age - Husband's age
```

```
*/
```

```
set more off
```

```
log using "SWPER.log"
```

```
*** Recoding the variables as it is required (Table 2 in the article) ***
```

```
gen union = inlist(v501,1,2) // Currently married or in union
```

```
lab var union "Currently married or in union"
```

```
lab val union yn
```

```
*** Excludes not partnered women ***
```

```
keep if union==1
```

```
*** Recoding missings from 9, 99, 999 to . ***
```

```
mvdecode v744a v744b v744c v744d v744e v731 v743a v743b v743d v157, mv(9)
```

```
mvdecode v133 v715 v730, mv(99)
```

```
*** Recoding the variables ***
```

```
*** Beating NOT justified variables ***
```

```
clonevar beat1=v744a
```

```

    recode beat1 0=1 1=-1 8=0
    label define beat -1"Yes" 0" Don't know" 1"No"
    label value beat1 beat
clonevar beat2=v744b
    recode beat2 0=1 1=-1 8=0
    label value beat2 beat
clonevar beat3=v744c
    recode beat3 0=1 1=-1 8=0
    label value beat3 beat
clonevar beat4=v744d
    recode beat4 0=1 1=-1 8=0
    label value beat4 beat
clonevar beat5=v744e
    recode beat5 0=1 1=-1 8=0
    label value beat5 beat

*** Decision variables ***
clonevar decide1=v743a
    recode decide1 4/6=-1 2/3=0
    label define decide -1"Husband/partner or other alone" 0"Respondent and husband/partner"
1"Respondent alone"
    label value decide1 decide
clonevar decide2=v743b
    recode decide2 4/6=-1 2/3=0
    label value decide2 decide
clonevar decide3=v743d
    recode decide3 4/6=-1 2/3=0
    label value decide3 decide

*** Wm education & work variables ***
clonevar educ=v133
    recode educ 98=.
clonevar work=v731
    recode work 3=2
    la define work 0"No" 1"In the past year" 2"Currently working"
    la value work work
clonevar read=v157
    recode read 3=2 // Most countries do not have the category "almost every day"(3), so we
recoded it to "At least once a week"(2).

*** Wm autonomy questions ***
clonevar age1cohab=v511

***Imputing age1birth for those women that do not have children***
recode age1cohab 33/max=33, gen (age1)
hotdeck v212, store by(age1) imp(1)
sort age1 v212

```

```

gen n=_n
preserve
    use "imp1.dta", clear
    gen n=_n
    rename v212 v212_i
    drop age1
    save, replace
restore
merge 1:1 _n using "imp1.dta"
erase "imp1.dta"

clonevar age1birth=v212_i

*** Husband variables ***
clonevar husb_educ=v715
    recode husb_educ 98=.          //Recode dk as missing
gen educ_diff= educ - husb_educ
    la var educ_diff "education difference: woman-husband years of schooling"
clonevar husb_age=v730
    recode husb_age 98=.          //Recode dk as missing
gen age_diff = v012 - husb_age
    la var age_diff "age difference: woman-husband"

*** Generating the Survey-based Women's emPOWERment (SWPER) Index ***
gen att_score=((-0.950)+(0.489*beat1)+(0.493*beat2)+(0.501*beat3)+(0.493*beat4)+
(0.546*beat5)+ (0.056*read)+(0.015*educ)+(-0.008*age1birth)+(-0.004*age1cohab)+
(0.002*age_diff)+(-0.004*educ_diff)+(0.008*decide1)+(-0.034*decide2)+(0.008*decide3)+
(-0.001*work))/1.818

gen soc_score=((-5.360)+(-0.006*beat1)+(-0.020*beat2)+(0.000*beat3)+(0.000*beat4)+
(-0.003*beat5)+(0.549*read)+(0.09*educ)+(0.141*age1birth)+(0.131*age1cohab)+
(0.026*age_diff)+(0.050*educ_diff)+(0.004*decide1)+(-0.013*decide2)+(-0.052*decide3)+
(-0.060*work))/1.475

gen dec_score=((0.857)+(-0.001*beat1)+(-0.040*beat2)+(0.007*beat3)+(0.026*beat4)+
(-0.014*beat5)+(0.150*read)+(0.026*educ)+(-0.019*age1birth)+(-0.006*age1cohab)+
(0.012*age_diff)+(-0.009*educ_diff)+(0.770*decide1)+(0.831*decide2)+(0.768*decide3)+
(0.180*work))/1.417

la var att_score "Std attitude to violence SWPER score"
la var soc_score "Std social independence SWPER score"
la var dec_score "Std decision making SWPER score"

```

Article 2

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Does women's empowerment increase coverage of RMNCH interventions in Africa? An analysis using a survey-based empowerment indicator, the SWPER.

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Abstract

Introduction

Women's empowerment has a strong potential to promote sustainable development. Our main objective was to evaluate the association between women's empowerment and the Composite Coverage Index (CCI), a weighted average of coverage with eight interventions in reproductive, maternal, newborn and child health. We will also assess whether these effects are modified by wealth.

Methods

We used Demographic and Health Survey data from 36 African countries. Women's empowerment was measured using the three domains (attitude to violence, social independence and decision making) of the survey-based indicator of women's empowerment (SWPER). Analyses followed an ecological design. Meta-regression models were used to account for within-country uncertainty in the CCI. We also carried out meta-regression with wealth quintiles as the units of analyses and tested for interaction between wealth and each empowerment domain.

Results

We found positive associations between the three domains of SWPER and CCI at country level. One standard deviation change in empowerment increased the CCI by 15 (attitude to violence and decision-making domains) and 23 percentage points (social independence). For the latter, the association was modified by wealth: each additional standard deviation was associated with 39.0 (95% CI: 26.2 – 51.9) and 9.7 (95% CI: 5.1 – 14.3) percentage points increase in the CCI among the poorest and the richest quintiles, respectively.

Conclusion

Our findings suggest that efforts toward the achievement of SDG5 (Achieve gender equality and empower all women and girls) may have important impact on health and health care utilization on the African continent, especially among the poorest women.

Keywords

Women's empowerment, personal autonomy, maternal health, maternal-child health services.

Research highlights

- CCI levels tended to be low, being under 50% in 11 out of the 36 countries.
- There is a positive relationship between women's empowerment and the CCI.
- The association between social independence and CCI is stronger among the poorest.

Introduction

In 2015 the United Nations launched a new set of objectives to guide countries towards sustainable development. Given its potential to promote economic growth, reduce poverty and accomplish human rights, women's empowerment is one of the Sustainable Development Goals. In 2017, a novel within- and between-country comparable survey-based women's empowerment indicator was proposed, the SWPER, allowing the assessment of women's empowerment levels in African countries (1).

The Countdown to 2030 is a monitoring and accountability initiative aimed at assessing country progress towards the SDGs. One of the Countdown innovations was the Composite Coverage Index (CCI), a summary measure of universal health coverage in Reproductive, Maternal, Newborn and Child Health (RMNCH) based on eight preventive and curative interventions along the continuum of care (2,3). The CCI is a group-level rather than an individual-level measure. It may be calculated at country level or for subgroups such as wealth quintiles or geographical regions. The CCI is able to reveal inequality patterns more precisely than separate coverage indicators, and is also a good predictor of the levels of child mortality and malnutrition (4).

Important gains in global coverage with RMNCH interventions have been made recently (5,6), but progress was uneven and major gaps persist both between and within countries (7,8). While RMNCH coverage has substantial variability across social strata, the effects of gender equity and empowerment are less well understood.

Understanding the effect of the women's empowerment on RMNCH coverage will inform the development of appropriate policies to reach all women and children. We investigated the association between women's empowerment in three domains (attitude to violence, social independence and decision making) and the CCI in 36 African countries. We also assessed whether these effects are modified by wealth.

Methods

We used the latest Demographic and Health Survey (DHS) data from 36 African countries, with survey years ranging from 2003 to 2015. Central African Republic, South Africa and the Republic of Congo were excluded because their surveys did not include all the variables required to estimate women's empowerment with the SWPER. The DHS are a series of nationally representative, cross-sectional health surveys conducted in low- and middle-income countries for which data is publicly available (9). As all surveys present similar questionnaires, methodology and sampling strategy (multi-stage cluster sampling), their results are comparable across countries.

Women's empowerment was measured using the three domains (attitude to violence, social independence and decision making) of the SWPER, a survey-based indicator of women's empowerment. It is based on 15 questions related to the women's opinion on whether beating the wife is justified in some situations, to who makes decisions in the household (in regard to the respondent's health care, major expenses and to visits to family and relatives) and to the women's work, access to information, educational attainment, age at marriage and first child, and difference in age and education between the woman and her husband. Full details on the construction of the index and its validity are presented elsewhere (1). The scores are standardized measures for which larger values mean higher levels of empowerment, and zero is the average value for Africa.

We used the CCI (composite coverage index) as a summary indicator for RMNCH intervention coverage. The CCI is an average of eight interventions along the four stages of the continuum of care, weighted in a way to give each stage the same weight (3,5). Its component indicators are: reproductive health - demand for family planning satisfied with modern methods (DFPSm); maternal health - at least four antenatal care visits (ANC4) and skilled birth attendance (SBA); immunization - three doses of diphtheria-tetanus-pertussis vaccine (DPT3), measles vaccine (MSL) and Bacillus Calmette-Guérin vaccine (BCG); management of child illness - oral rehydration salts for children with diarrhea (ORS) and

care-seeking for children with suspected pneumonia (CPNM) (3). The CCI is calculated by the expression:

$$CCI = \frac{1}{4} \left(DFPSm + \frac{ANC4 + SBA}{2} + \frac{BCG + 2DPT3 + MSL}{4} + \frac{ORS + CPNM}{2} \right)$$

The CCI is measured at group level and was calculated at national level and for wealth quintiles. All the coverage indicators were calculated according to standard Countdown to 2030 definitions (3). The wealth index, an asset index derived through principal component analysis was calculated for each household and included in the DHS datasets. (10) This wealth index is divided into quintiles within each country, with Q1 representing the 20% poorest and Q5 the 20% richest households.

Meta-regression models were used to account for the CCI within-country uncertainty, as measured by the standard errors. Meta-regression is an extended version of the variance weighted least squares that considers an additional variance component, which is assumed to be equal across units. Analyses were not weighted by the countries' population size. Analyses were performed using countries as the unit of analyses, both unadjusted and adjusted by the log of the Gross Domestic Product (GDP) per capita adjusted by the purchase power parity in international dollars (11), considering the GDP as a potential confounder. To evaluate whether the household wealth modifies the effect of empowerment, we also carried out meta-regression with wealth quintiles as the unit of analysis and tested the interaction between wealth and each domain of the SWPER.

Estimates and respective standard errors accounted for the sample design, including clusters, strata and sample weights. All analyses were conducted using the Stata software (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LP).

Results

A description of the countries in terms of national CCI and mean women's empowerment level in each SWPER domain is presented in Table 1. Generally, the CCI was low, with 11 out of the 36 countries

analyzed with a CCI below 50%. The CCI varied greatly across the countries, with the lowest value in Chad (28.9%) and the highest in Egypt (78.4%). As mentioned in the methods section, countries with positive SWPER values are faring better than the African average in terms of women's empowerment. Guinea, Chad, Niger, Burkina Faso, Mali and Ethiopia present the lower SWPER scores for the three domains, while Namibia and Swaziland present the highest scores and also some of the highest CCI levels (77.0% and 78.1%, respectively). Egypt has the highest CCI (78.4%), and a high score for social independence. However, its scores for the other domains are much smaller, albeit still positive.

All three domains of empowerment were positively associated with the CCI. Pearson's correlation coefficients were 0.54, 0.73 and 0.55 for attitude to violence, social independence and decision making, respectively. At country level, we found that the CCI increased by 15.3 (95% CI: 7.1 – 23.5), 23.0 (95% CI: 15.5 – 30.6) and 15.3 (95% CI: 7.3 – 23.3) percentage points, on average, for each standard deviation in attitude to violence, social independence and decision making, respectively. The effects did not change in any meaningful way after adjustment for the GDP per capita (Table 2).

We then performed stratified analyses by wealth quintiles to investigate whether the effect of the women's empowerment on the CCI was modified by wealth. There was no evidence that the effects of attitude to violence and decision making changed with wealth (p-values for interaction were, respectively, 0.93 and 0.94). In contrast, there was a strong interaction between wealth and social independence (p-value for interaction <0.001), with stronger associations among the poor. In the poorest quintile, one additional standard deviation in the social independence domains was associated with 39.0 (95% CI: 26.2 – 51.9) percentage points increase in the CCI (Table 3). Among the richest, this effect was much smaller, at 9.7 percentage points (95% CI: 5.1 – 14.3).

Discussion

We present a set of analyses of the association between women's empowerment, using a newly proposed survey-based indicator, on the CCI, a combined measure of RMNCH intervention coverage.

We found positive relationships between the three domains of women's empowerment, as measured by the SWPER, and the CCI at country level. The associations were statistically significant and programmatically relevant. One standard deviation in the attitude to violence and decision-making domains was associated with an increase of 15 percentage points in the CCI, whereas for social independence the increase equaled 23 percentage points. Also, the latter association was strongest in the poorest wealth quintile.

The social independence domain is mainly comprised of socio-demographic measures of life history (education, age at marriage, age at first birth, age and education gap with spouse) and by access to information. Such tangible measures may be more strongly associated with CCI because they reflect the women's agency more directly than the items in the decision-making and attitude to violence domains, which are more reflective of family and community norms, which may constitute distal determinants in the processes that feed into intervention coverage. Our results are in line with the literature, that has shown that wife beating norms are related to actual partner violence (12), which in turn has been associated with compromised RMNCH (13,14).

We hypothesized that the effect of women's empowerment on the CCI could be modified by wealth because richer families systematically present higher coverage with RMNCH interventions, so that less effort is needed to achieve high coverage in this group. Also, fewer restrictions in access to health resources and in terms of decision-making by women are generally experienced among the richer groups (15). The interaction with wealth was only significant for the social independence domain.

Our results show that the poorest women may experience a particular benefit from empowerment in social independence that is, on average, over four times greater than the richest. Our finding of a 39 percentage points increase in the CCI per standard deviation change in the social independence domain is striking, but one should bear in mind that the range of national values for this domain is equal to 1.7 standard deviations, from -0.6 in Chad to 1.1 in Namibia. Prior research has documented

that government effectiveness and political stability/absence of violence are also more strongly associated with RMNCH interventions among the poorest than the richest quintile (8). The authors argued that the wealthier may benefit from safety nets that make them less dependent on state-provided services, which allows richer families to offset poor governance. The same argument is also valid to explain our findings and suggests that greater efforts to support empowerment broadly, and social independence (e.g., education, delayed marriage) in particular, are required amongst the poorest women to improve their access, and that of their children, to essential RMNCH health interventions.

All the coverage indicators comprised by the CCI are based on maternal recall. Recall can be nondifferential or differential. Nondifferential recall would dilute the existing associations, however differential recall, which may happen if women have different recollections depending on their wealth or empowerment status, would lead to bias. Another potential source of bias is that the surveys included in the analyses were conducted over 12 years and changes in gender relations might have occurred. However, it is known that these changes are generally slow and the correlation between the year of the survey and the three empowerment domains were all between -0.02 and 0.05, ruling out this potential source of bias.

Wealth quintiles are country-specific relative measures, this means that the poorest quintile in a middle-income country may be wealthier than the richest quintile in an extremely poor country. Also, irrespective of the actual magnitude of intra-country wealth inequalities, all samples will be represented with five groups containing about 20% of the households. Despite these limitations, use of wealth indices allows the systematic analyses of inequalities in health that would not be warranted with other measures of socioeconomic status (7). Also, the strong association between the wealth index and most coverage indicators demonstrates its effectiveness to discriminate subpopulations.

This is an ecological exploratory analysis, so we cannot infer causality from the results. One of the limitations of the SWPER is that it is restricted to partnered women, but given the ecological design of this study, we believe analyses based on all women not substantially impact the results. There are also limitations to summary measures such as the ones used in this paper, as they may mask differences in the individual indicators comprising the summary measure. Nonetheless, the advantages of the SWPER are substantial, including direct cross-country comparability (16). In addition, the analyses based on three domains allow an understanding of which aspects of women's empowerment are most strongly associated with RMNCH coverage across countries. Identifying high and low performers opens avenues for policy makers to further investigate these gaps and initiate measures to accelerate progress in line with the SDGs.

Conclusion

Cross-national analysis shows strong associations between gender empowerment and the CCI in African countries, particularly in the area of women's social independence. The poorest women are most affected by the association between disempowerment and RMNCH intervention coverage. These findings suggest that efforts toward the achievement of SDG5 (Achieving Gender Equality and Empowerment) may have important impact on health and health care utilization on the continent. However, changes in gender relations are hard, slow processes, as they challenge people to change attitudes and practices that are undermined by contextual social norms (17,18). Our findings, jointly with the call for change in gender relations issued by the SDGs, will give more prominence to this crucial issue. Universal health coverage can never be achieved with half of the population being socially marginalized.

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Figure 1. Effect of women’s empowerment for each of the three domains of the SWPER (attitude to violence, social independence and decision making) on the composite coverage index (CCI) at national level.

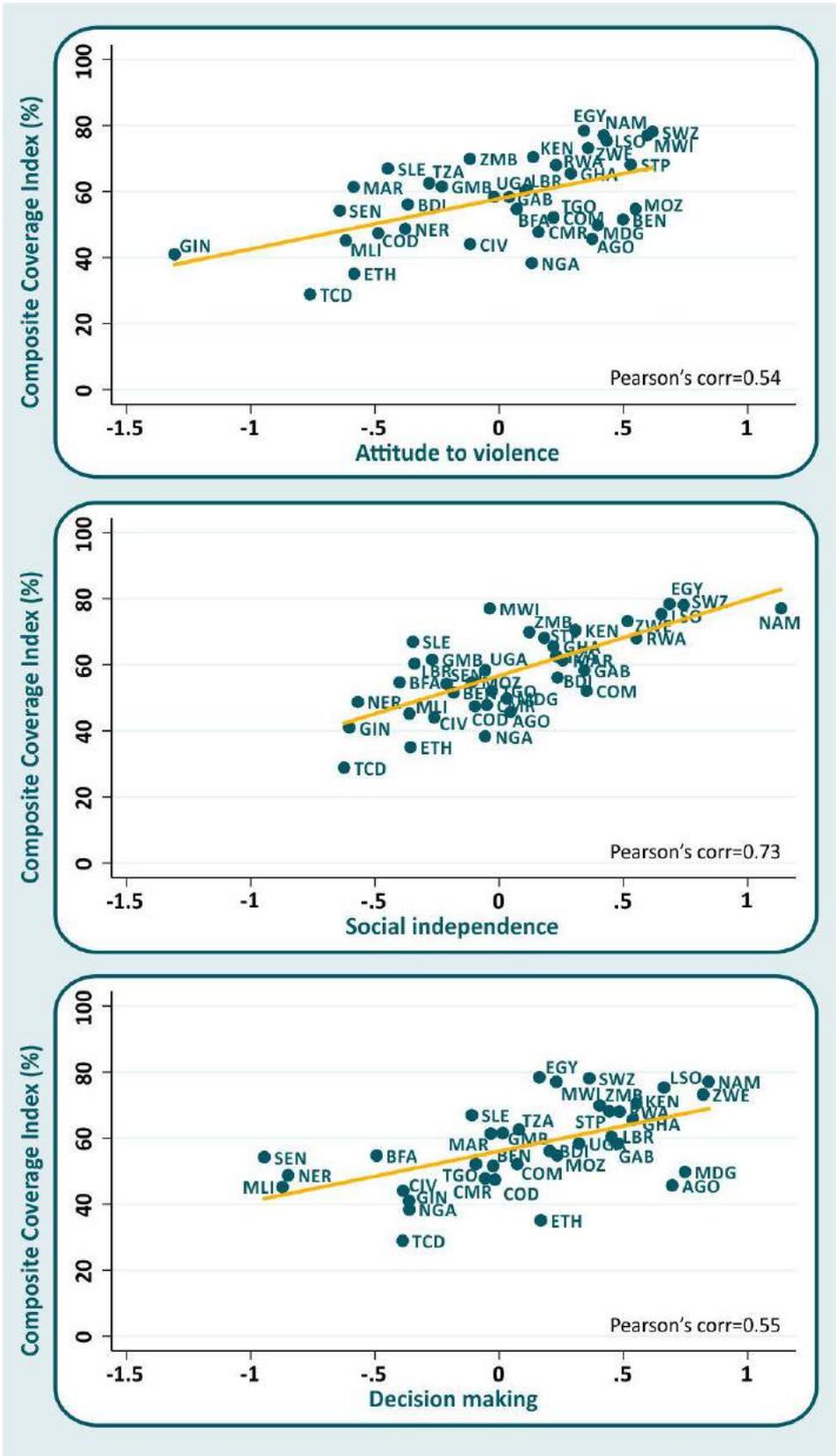


Figure 2. Effect of women’s empowerment for each of the three domains of the SWPER (attitude to violence, social independence and decision making) on the composite coverage index (CCI) for each of the five wealth quintiles.

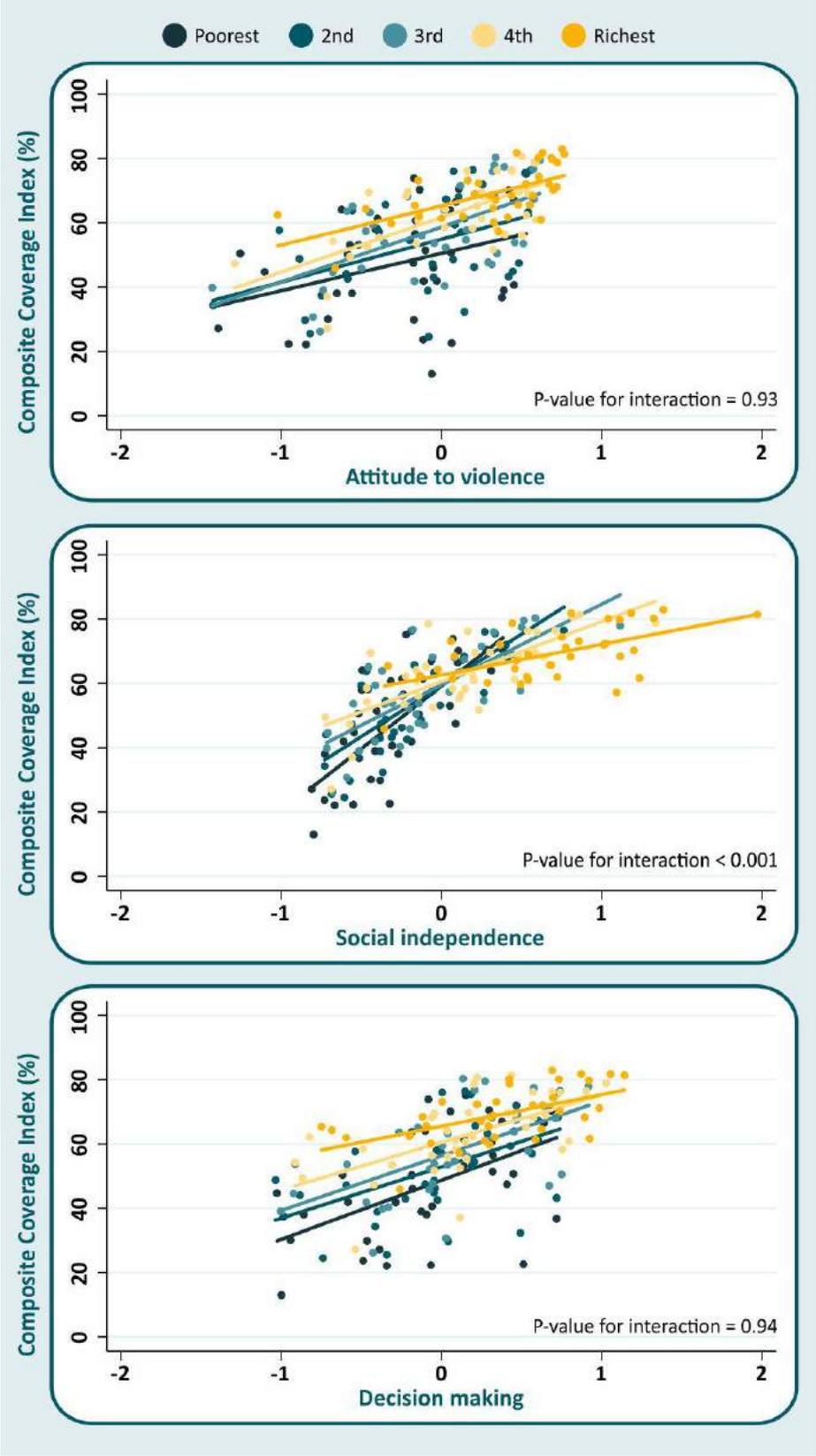


Table 1. List of countries included in the analyses, with their ISO-codes, year of the survey, Composite Coverage Index estimate and mean women's empowerment level in attitude to violence, social independence and decision making.

Country	Survey year	ISO code	CCI (%)	Mean women's empowerment		
				Attitude to violence	Social independence	Decision making
Angola	2015	AGO	45.7	0.37	0.05	0.70
Benin	2011	BEN	51.5	0.50	-0.18	-0.03
Burkina Faso	2010	BFA	54.7	0.07	-0.40	-0.49
Burundi	2010	BDI	56.1	-0.37	0.23	0.20
Cameroon	2011	CMR	47.8	0.16	-0.05	-0.06
Chad	2014	TCD	28.9	-0.76	-0.62	-0.39
Comoros	2012	COM	52.1	0.22	0.35	0.07
Congo, Democratic Republic of the	2013	COD	47.4	-0.49	-0.10	-0.02
Côte d'Ivoire	2011	CIV	44.1	-0.12	-0.26	-0.39
Egypt	2014	EGY	78.4	0.34	0.69	0.16
Ethiopia	2011	ETH	35.1	-0.58	-0.36	0.17
Gabon	2012	GAB	58.3	0.04	0.34	0.48
Gambia	2013	GMB	61.5	-0.23	-0.27	0.01
Ghana	2014	GHA	65.5	0.29	0.22	0.54
Guinea	2012	GIN	41.0	-1.31	-0.60	-0.36
Kenya	2014	KEN	70.5	0.14	0.31	0.55
Lesotho	2014	LSO	75.3	0.43	0.65	0.66
Liberia	2013	LBR	60.3	0.11	-0.34	0.45
Madagascar	2008	MDG	49.8	0.40	0.03	0.75
Malawi	2015	MWI	77.0	0.60	-0.04	0.23
Mali	2012	MLI	45.2	-0.62	-0.36	-0.87
Morocco	2003	MAR	61.4	-0.59	0.25	-0.03
Mozambique	2011	MOZ	54.7	0.55	-0.11	0.23
Namibia	2013	NAM	77.0	0.42	1.13	0.84
Niger	2012	NER	48.7	-0.38	-0.57	-0.85
Nigeria	2013	NGA	38.3	0.13	-0.06	-0.36
Rwanda	2014	RWA	68.0	0.23	0.55	0.48
São Tomé and Príncipe	2008	STP	68.1	0.53	0.18	0.44
Senegal	2014	SEN	54.2	-0.64	-0.21	-0.94
Sierra Leone	2013	SLE	66.9	-0.45	-0.35	-0.11
Swaziland	2006	SWZ	78.1	0.62	0.74	0.36
Tanzania	2015	TZA	62.6	-0.28	0.23	0.08
Togo	2013	TGO	52.1	0.22	-0.03	-0.09
Uganda	2011	UGA	58.3	-0.02	-0.06	0.32
Zambia	2013	ZMB	69.9	-0.12	0.12	0.40
Zimbabwe	2015	ZWE	73.2	0.36	0.52	0.82

Table 2. Meta-regression effects of each empowerment domain on the countries' Composite Coverage Index (CCI). (n=36 countries)

	Crude		Adjusted ¹	
	Coefficient	95% CI	Coefficient	95% CI
Women's empowerment				
Attitude to violence	15.3	7.1 – 23.5	13.9	5.4 – 22.4
Social independence	23.0	15.5 – 30.6	25.4	16.3 – 34.5
Decision making	15.3	7.3 – 23.3	14.0	5.7 – 22.3

¹ Adjusted by log GDP per capita (PPP, I\$).

Table 3. Meta-regression unadjusted effects of each empowerment domain on the countries' Composite Coverage Index (CCI) by wealth quintile. (n=36 countries)

	Women's empowerment					
	Attitude to violence		Social independence		Decision making	
	Coeff	95% CI	Coeff	95% CI	Coeff	95% CI
Wealth quintiles						
Q1 (poorest)	11.6	0.2 – 23.1	39.0	26.2 – 51.9	18.4	7.9 – 29.0
Q2 (poorer)	13.4	4.1 – 22.7	31.8	22.6 – 41.1	15.9	6.9 – 25.0
Q3 (middle)	17.1	9.0 – 25.2	25.1	17.4 – 32.7	17.1	9.1 – 25.1
Q4 (richer)	17.0	10.4 – 23.6	18.7	12.8 – 24.6	14.9	8.0 – 21.8
Q5 (richest)	12.3	7.0 – 17.6	9.7	5.1 – 14.3	10.0	4.9 – 15.0

Article 3

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The impact of women's empowerment on their children's early development in 16 African countries.

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Abstract

Introduction

Every year more than 200 million children under-five years fail to achieve their full developmental potential in low- and middle-income countries. We aimed at exploring whether the mothers' empowerment is associated with early childhood development in 16 African countries.

Methods

We used data from Demographic and Health Surveys and Multiple Indicator Cluster Surveys ranging from 2010 to 2014. Four developmental domains were assessed among children aged 36-59 months using the Early Childhood Development Index: literacy-numeracy, physical, learning and socioemotional. Women's empowerment in attitude to violence, social independence and decision-making was evaluated using the SWPER, a survey-based validated index. We used logistic regressions to estimate the effects of each empowerment domain on the child development. Meta-regressions were performed to combine the countries' effects taking their sample sizes into account.

Findings

On average, 14.3%, 92.0%, 80.4% and 65.7% of the children were on track for literacy-numeracy, physical, learning and socioemotional developmental domains, respectively. Overall, for each standard deviation increase in attitude to violence, social independence and decision-making, the odds for the child being on track on literacy-numeracy increased 31%, 90% and 31%, respectively. Generally, the mothers' empowerment effects on the physical, learning and social-emotional development of the child was very small or null.

Interpretation

Mothers' empowerment, especially the social independence domain, has a consistent and strong effect on the child's literacy-numeracy development cross-nationally in Africa. The low or null effects found for the other domains may be related to the low variability of the outcomes.

Funding

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Research in context

Evidence before this study

We did an extensive literature search, through PubMed, POPLINE, Google, and to our knowledge, no study to date has examined the associations between gender empowerment and early childhood development in low- and middle-income countries.

Added value of this study

This study adds to the literature by analyzing this association in the African countries, which present high gender inequalities and some of the worse scenarios considering the development of the children. We showed that the mothers' empowerment has a consistent and strong effect on the child's development of literacy-numeracy skills cross-nationally in Africa, especially considering the SWPER social independence domain.

Implications of all the available evidence

Empowering women has a great potential to improve health and economic outcomes both at household and community level. Our results indicate that programs and interventions aimed at improving the children's future perspectives to thrive throughout their lives should also target the empowerment of women and the reduction of gender inequalities.

Introduction

Every year more than 200 million children under-five years of age from Low- and Middle-Income countries (LMICs) fail to achieve their full potential in cognitive development.¹ In 2012, the international community embraced the cause, including universal access to early childhood development, care and preprimary education as a target on the Sustainable Development Goals (SDGs). This is a step beyond the Millennium Development Goals, which only targeted child survival. In the SDG era, child survival is not enough anymore. International organizations, governments and policy makers now also committed to guarantee that all children also thrive.²

The first five years of the child's life are critical for their cognitive, social, and physical development.³ This period is an important window for investments, since interventions focused on early childhood development are the most cost-effective approaches to increase educational achievements and productivity in adulthood.^{2,4} Failing to promote the achievement of the children developmental potential may also sustain the intergenerational transmission of poverty.^{1,5}

The environment is a key determinant of the child's chances to survive and properly develop.⁵ Ideal development of a child's brain requires a stimulating environment, social interactions with dedicated caregivers and adequate food and nutrients intake.^{4,6} However, poverty, discrimination, conflict and other forms of individual, family and community stress, create barriers for families' to provide appropriate and nurturing care for the child.⁷ This may be exacerbated in contexts where gender inequalities and women's marginalization are common by compromising the mothers' agency to provide for the child.

In LMICs, many women are still deprived of claiming their rights and of being able to make decisions about the direction of their lives.⁸ In some places, even the freedom to obtain healthcare for herself or for her children can be denied. With potential to promote economic growth, reduction of poverty and the accomplishment of human rights, the empowerment of the women is also targeted by the SDGs.⁹ More empowered women, as indicated by factors such as higher education and delayed marriage, have higher coverage with modern contraceptive use and higher access to maternal health supports such as antenatal care and skilled birth attendance.¹⁰⁻¹³ They also generally desire a smaller number of children, which allow them to provide better care to each child.¹⁴ Findings from a study conducted in sub-Saharan Africa and South Asia showed that the more women controlled the economic resources in the household, the more money was spent with their children.¹⁵ Thus, more empowered women would be more likely to provide their children with appropriate care and nutrition, improving their chances to survive and properly develop.

Data on early child development are scarce in LMICs. The UNICEF recently started collecting data for the Early Childhood Development Index, which allows the assessment of four developmental domains: literacy-numeracy, physical, socioemotional and learning. To our knowledge, no study has ever evaluated the effect of the mothers' empowerment level on the development of the child in LMICs settings. This study adds to the literature by analyzing this association in African countries, which present high gender inequalities and some of the worse scenarios considering the development of the children.^{6,16} We then set out to explore, in 16 African countries with available data, whether the mothers' gender empowerment is associated with child development.

Methods

We used data from Multiple Indicator Cluster Surveys (MICS) or the Demographic and Health Surveys (DHS) as both have similar questionnaires and sampling strategies. Items to assess early childhood development have been added to the MICS questionnaires since 2009, in the round 4, and it has been included in some DHS since its sixth wave, that started in 2010.¹⁷ We selected the latest survey for each country in Africa for which the early childhood development module had been applied, either in MICS or DHS, with 16 countries being available (see Table 1).

1.1 Early Child Development

Early child development was measured by the early childhood development index (ECDI), a cross-culturally tested tool developed by UNICEF. This tool is a multidimensional index composed of ten questions directed to the child's mother or primary caregiver designed to assess the development of children aged 36 to 59 months.⁴ The ECDI assesses four developmental domains: literacy-numeracy, physical, learning and social-emotional. The response categories for all questions are "yes", "no", and "don't know". For each domain the child is considered on track according to the number of items achieved. For example, the literacy-numeracy domain is composed by three items (child can identify/name at least ten letters of the alphabet; child can read at least four simple, popular words; and child knows the name and recognizes the symbol of all numbers from 1 to 10) and the child is considered on track in this domain if at least two of these items are achieved. Overall, the child is considered developmentally on track if at least three of the four domains were considered on track. The complete description of the ECDI questions and its operationalization to determine whether the child is developmentally on track in each domain is presented in Box 1. We analyzed each ECDI domain separately and the composite ECDI score according to this operationalization.

Box 1. Operationalization of the ECDI in children aged 36-59 months.

- (1) *Literacy-numeracy*: Children are considered developmentally on track if at least two of the following is true: Can identify/name at least ten letters of the alphabet; can read at least four simple, popular words; knows the name and recognizes the symbol of all numbers from 1 to 10.
- (2) *Physical*: Children are considered developmentally on track if one or both of the following is true: can pick up a small object with two fingers, like a stick or a rock from the ground; is **not** sometimes too sick to play.
- (3) *Learning*: The child is identified as being developmentally on track if one or both of the following is true: follows simple directions on how to do something correctly; when given something to do, is able to do it independently.
- (4) *Social-emotional*: The child is identified as being developmentally on track if at least two of the following is true: gets along well with other children; does **not** kick, bite, or hit other children; does **not** get distracted easily.

Overall, the child is developmentally on track if at least three of the four component domains were considered to be on track.⁴

Women's empowerment

Maternal gender empowerment was measured by the Survey-based Women's emPOWERment (SWPER) index.¹⁸ This is an individual level measure which assesses three domains of empowerment: attitude to violence, social independence and decision making. It is based on 15 questions related to the women's opinion on beating the wife being justified in some situations, to who makes decisions in the household (regarding the respondent's health care, large expenses and visits to family and relatives) and to the women's work, access to information, educational attainment, age at marriage and first child, and difference in age and education to the husband (Table A1 in the Web Appendix). The SWPER provides continuous standardized scores, so that a zero score means that the woman is at an average level of empowerment compared to the set of African countries used to develop the index. A positive score means higher empowerment than average and a negative score, the opposite. Full details on the construction of the index and its validity are presented elsewhere.¹⁸

Missing data

Some women did not have complete information on all the items needed to calculate the SWPER scores and some surveys included in this analysis did not collect information on some variables used for the SWPER. For instance, MICS does not provide the husband's education nor any information on the woman's participation in household decisions. To overcome the husband's education issue, we used the head of the household's years of schooling as a proxy of the husband's education. But to estimate the SWPER scores we had to impute all the other missing data. We used multiple imputation for these missing variables by design (questions not included in the survey questionnaire) and for those cases where the answers for individual women were missing. We assumed that the data were missing at random. More details on the imputation process are presented in the Web Appendix. The distribution of the empowerment scores with imputed items was very similar to the distribution of the complete cases (Figure A1 in the Web Appendix). For the MICS surveys, the decision-making items were imputed to allow the calculation of the attitude to violence and social independence domains, but the decision-making domain will not be analyzed in these surveys as all information was imputed.

Statistical analyses

Were included in the analyses children aged 36-59 months living with the mother. As most of the questions related to women's empowerment available in the surveys were restricted to partnered women, the SWPER index can only be calculated this group. Thus, single mothers' children are not included in the analysis.

We used logistic regressions to assess the effect of maternal gender empowerment on the child development in each ECDI domain plus the composite ECDI index. Crude and adjusted analyses were performed to evaluate whether adjusting for wealth the effects would be changed. There was no clear evidence that the sex of the child modified the effects, thus all children were analyzed together. Rubin's rules (15) were applied to combine the results of the multiple imputed datasets utilizing the command '*mi estimate*' on the statistical software Stata (StataCorp. Stata Statistical Software: release 14. College Station, TX: StataCorp LP; 2015). To get an overall effect and achieve higher statistical power, meta-regressions were performed to assess the pooled odds ratios for the association between the gender empowerment and child development domains. Meta-regressions are statistical analyses that combine the results of multiple studies (or, in this case, of multiple countries), weighting each study result by their sample size. Lastly, we performed a sensitivity analysis by generating a new social independence measure that excluded the mothers' education and executing the same logistic and meta-regressions. The command '*svy*' was used in all the analyses to account for the surveys' sample

design. Both DHS and MICS are public sources of information and ethical approval has already been obtained from each country by the time of the survey conduction.

Results

Survey data collection ranged from 2010 to 2014, with 12 surveys from West and Central Africa, and only four surveys from Eastern and Southern Africa (Table 1). No data was available for this analysis from a Northern African country. In seven countries (Rwanda, Zimbabwe, Chad, Togo, Central African Republic, Guinea-Bissau and Sierra Leone), less than 10% of the children were on track on literacy-numeracy. Ghana and Nigeria presented the best performance in this domain, 29.3% and 31.5% were on track, respectively. The literacy-numeracy average across countries was 14.3%. The vast majority of children were considered on track for the physical and learning developmental domains (92.0% and 80.4%, respectively). The physical domain had the lowest variation across countries, ranging from 88.8% in Sierra Leone to 97.4% in Ghana. Regarding the social-emotional domain, 65.7% of the children were on track, on average. Overall, 56.8% of the children were on track for the composite ECDI (i.e., on track in at least three out of the four domains). Chad presented the worst performance, with only 32.1% of the children on track on the composite ECDI, contrasting with Ghana where more than 75% of children were on track.

Figure 1-4 present the crude effect of the mothers' gender empowerment as measured by the three domains of the SWPER (attitude to violence, social independence and decision-making) on each child developmental domain separately. The effects are the odds ratios for a standard deviation increase in the SWPER score. These figures also present the overall effect for all the countries, weighted by their sample sizes.

Considering the domains separately, all countries presented a positive effect of social independence on the literacy-numeracy developmental domain, with São Tomé e Príncipe as the only exception, showing no effect (Figure 1). For attitude to violence and decision-making the effects also tended to be positive, but in many countries the confidence intervals were also consistent with the null hypothesis of no effect. São Tomé e Príncipe was the exception again, indicating that one standard deviation increase in the attitude to violence score was associated to 13% lower odds of having a child on track on literacy-numeracy, but the confidence interval range is also compatible with a null or a positive effect. Overall, for each standard deviation increase in attitude to violence, social independence and decision-making scores, the odds for the child being on track on literacy-numeracy increased 31% (OR 1.31; 95% CI: 1.26 – 1.36), 90% (OR 1.90; 95% CI: 1.86 – 1.94) and 31% (OR 1.31;

95% CI: 1.23 – 1.39), respectively. We performed a sensitivity analysis by excluding education from the social independence SWPER domain, as it could be driving the positive results. However, the overall effect was not strongly affected by the exclusion of the mothers' education (Overall OR 1.80; 95% CI: 1.75 – 1.86).

Generally, the effect of the mothers' gender empowerment on the physical, learning and social-emotional development of the child was very small or null (Figures 2 – 4). The overall effect on the physical domain was 8% (OR 1.08; 95% CI: 1.03 – 1.13), 8% (OR 1.08; 95% CI: 1.03 – 1.13) and 0% (OR 1.00; 95% CI: 0.93 – 1.08), respectively, for attitude to violence, social independence and decision-making domain. Swaziland was the only country that presented strong effects in Figure 2 and 3, indicating that one standard deviation change in the mothers' attitude to violence score increased the child's likelihood to be on track by 2.1 times (95% CI: 1.62 – 2.61) on the physical domain and by 1.69 times (95% CI: 1.03 – 2.35) on the learning domain. In Figure 4, Rwanda stands out with the higher effect of in the mothers' attitude to violence on the child's social-emotional development (OR 1.54; 95% CI: 1.41 – 1.66).

The effects adjusted by wealth for each developmental domain separately can be found in the Web Appendix (Figures A2 – A5). Generally, the results for the literacy-numeracy are attenuated, but the patterns remain similar to the crude ones. After adjustment by wealth, we found that overall each additional standard deviation in the mothers' gender empowerment in attitude to violence, social independence and decision-making increased the odds of the child to be on track in literacy-numeracy by 9% (OR 1.09; 95% CI: 1.05 – 1.14), 35% (OR 1.35; 95% CI: 1.30 – 1.39) and 19% (OR 1.19; 95% CI: 1.11 – 1.27), respectively. In the other domains, with a few exceptions, the overall effects were very small or null after adjustment by wealth. The combined effects of attitude to violence on the physical and socio-emotional development of the child remained statistically significant after adjustment, but the effects were reduced to 7% (OR 1.07; 95% CI: 1.02 – 1.12) and 8% (OR 1.08; 95% CI: 1.05 – 1.11), respectively. For the learning development, the decision-making empowerment was the only domain that remained statistically significant after adjustment, indicating that the likelihood of child being on track in raised 16% (OR 1.16; 95% CI: 1.10 – 1.21) for each standard deviation increase in the mothers' decision-making empowerment.

The same analyses are also presented for using the composite ECDI as the outcome (Figure A6 in the Web appendix). Overall, the effect of the attitude to violence, social independence and decision-making domains were, respectively, of 13% (OR 1.13; 95% CI: 1.10 – 1.16), 22% (OR 1.22; 95% CI: 1.19 – 1.25) and 16% (OR 1.16; 95% CI: 1.11 – 1.21) on the ECDI. With only a few exceptions – Chad, Mauritania and Sierra Leone in attitude to violence and Sao Tome and Principe in social independence

– all countries presented a positive effect of the mothers' gender empowerment level on the child's development. After adjustment by wealth, the overall effects were reduced to 8% (OR 1.08; 95% CI: 1.05 – 1.11), 10% (OR 1.10; 95% CI: 1.07 – 1.13) and 13% (OR 1.13; 95% CI: 1.08 – 1.18) for the attitude to violence, social independence and decision-making domains, respectively (Figure A7 in the Web appendix).

Discussion

To our knowledge, no study to date has examined the associations between gender empowerment and early childhood development in LMICs. On average, 14.3%, 92.0%, 80.4% and 65.7% of the children were on track for literacy-numeracy, physical, learning and socioemotional developmental domains, respectively. We showed that the mothers' empowerment has a consistent and strong effect on the child's development of literacy-numeracy skills cross-nationally in Africa, especially considering the SWPER social independence domain. However, the mothers' empowerment presented only a small (or null) effect on the other developmental domains.

In the African context, where many countries are still struggling to have reliable data on child mortality, having a good measure of child development is not easy. The ECDI was developed by UNICEF with the objective to fill this gap, however this indicator is not free of limitations. Almost all the children were on track in the physical and learning domains, which characterizes a ceiling effect for these measures. That means that, generally, the items comprised in each of these domains are too easily achieved by the children, so that almost all are considered on track. The low effects found for the physical and learning domains can be related to the tests' inability to discriminate the children. Also, considering the tests seem too easy for the 3-4-year-olds, the children that failed them are likely to have other health or mental conditions. For example, in the physical domain, the pincer grasp item represents a skill normally developed before one year of age, so it would only capture severe developmental setbacks in children aged 36-59 months.¹⁷ The same authors argue that being too sick to play – also in the physical domain – would represent the children's health status rather than their early developmental skills.

Each additional standard deviation in the social independence empowerment level of the mother almost doubles the child's odds of being on track on literacy-numeracy. This empowerment domain is comprised by items related to the mothers' education, age at first birth and age at first cohabitation and the age and education difference between the woman and her partner. There is a large body of literature reporting the effect of the parent's education on the development of the child.^{6,19,20} However, sensibility analysis evidenced that this effect was not driven solely by the mothers' education, representing the effect of the mothers' social independence as a whole.

Besides all the criticism around the ECDI, having a cross-culturally validated standard measure is an extremely valuable advance in the field. In many LMICs this is the only child development measure available. The ECDI opens innumerable new research opportunities and has potential to make governments and policy makers accountable regarding the countries' advances. However, the ceiling effects may indicate that the ECDI will require adjustments to allow the monitoring of the progress towards the SDGs until the year 2030.

Single mothers' children are generally more likely to face poverty and poor health outcomes than children that have a nuclear family²¹, but the gender empowerment measure we used can only be calculated for partnered women. Additionally, there is a number of children who do not live with their mothers, and which did not take part in our analyses. Therefore, we cannot extrapolate the results for strictly all children aged 36-59 months in the countries analyzed, but the ones included in our study are certainly the large majority. Another limitation is that measurement error could be present, either for the predictors or the outcomes, and this was not taken into account in the analyses.

As both child development and women's empowerment are strongly associated with wealth, by adjusting the analyses we aimed to evaluate whether there was an association between the maternal empowerment and the child development independent of wealth (we were not implying that wealth causes empowerment, or the reverse). After adjustment, the effects were slightly reduced but the patterns were stable. This indicates that independent of the wealth, the mothers' empowerment level still has an effect on the development of the children, especially for the literacy-numeracy developmental domain, for which the effect remained strong and positive (results presented in the Web Appendix).

Empowering women is a goal in itself, but it also has a great potential to improve health and economic outcomes both at household and community level. We showed that maternal empowerment increases the odds of children to achieve better developmental outcomes in the literacy-numeracy domain. Thus, programs and interventions aimed at improving the children's future perspectives to thrive throughout their lives should also target the empowerment of women and the reduction of gender inequalities.

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Table 1. Sample sizes and prevalence (%) of children age 36-59 months who are developmentally on track in literacy-numeracy, physical, learning and social-emotional domains, and in the Early Child Development Index.

Region	Country	Year	Source	% Children 36-59 months who are on track by developmental domain ²				ECDI ³	Sample size ¹
				Literacy- numeracy	Physical	Learning	Social- emotional		
Eastern & Southern Africa	Rwanda	2014	DHS	7.3	95.2	86.2	81.9	71.3	2,193
	Malawi	2013	MICS	17.6	89.3	80.6	72.0	60.8	5,922
	Swaziland	2014	MICS	20.5	93.7	93.6	64.9	66.8	514
	Zimbabwe	2014	MICS	9.9	92.4	87.1	65.1	60.0	2,819
West & Central Africa	Cameroon	2011	DHS	17.2	92.8	82.5	52.4	49.8	1,588
	Chad	2014	DHS	5.3	83.5	54.0	59.5	32.1	3,978
	Congo Brazzaville	2011	DHS	12.8	87.5	80.3	55.5	49.1	2,402
	Congo, DR	2013	DHS	10.4	92.2	79.9	78.3	64.5	2,522
	Togo	2013	DHS	8.4	92.6	70.4	75.4	53.9	2,165
	Central African Republic	2012	MICS	7.2	95.5	74.2	58.0	46.7	2,896
	Ghana	2010	MICS	29.3	97.4	89.4	74.4	75.2	2,428
	Guinea-Bissau	2014	MICS	7.2	89.9	86.9	72.7	61.1	2,062
	Mauritania	2011	MICS	19.1	93.3	89.6	56.1	58.2	2,862
	Nigeria	2014	MICS	31.5	93.2	77.5	65.2	60.1	8,520
	Sao Tome and Principe	2014	MICS	16.2	94.0	78.5	61.4	53.8	580
Sierra Leone	2010	MICS	8.6	88.8	76.1	58.9	44.9	2,572	
Overall				14.3	92.0	80.4	65.7	56.8	46,023

Notes: ¹ Children aged 36-59 months living with the mother; restricted to partnered mothers.

² Please see Box 1 for the items included in each developmental domain.

³ Children are considered developmentally on track on the Early Child Development Index (ECDI) if they are on track in at least three of the four developmental domains.

Figure 1. Association between *literacy-numeracy development* of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the crude odds ratios (OR) for a standard deviation increase in the SWPER score.

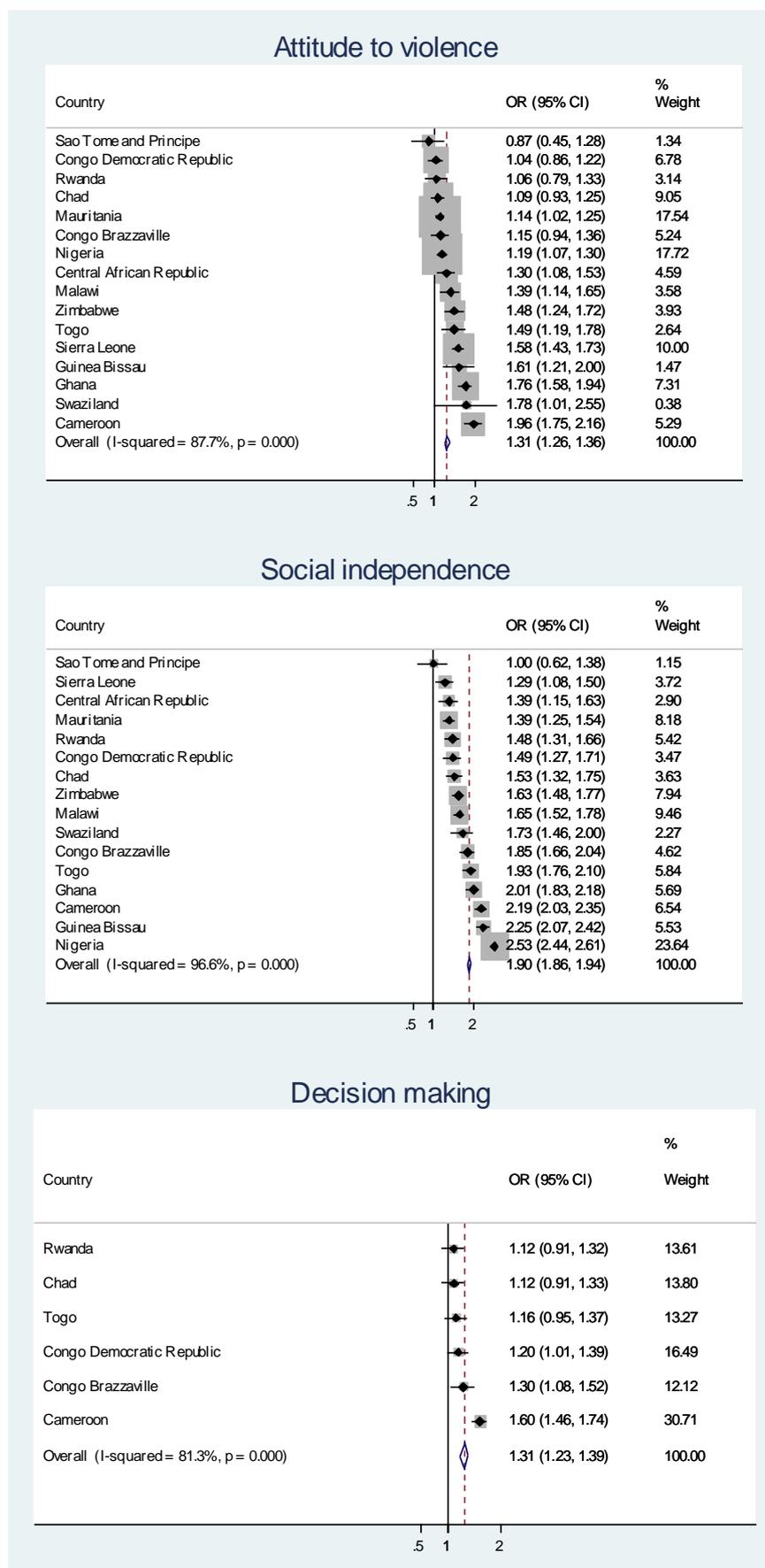


Figure 2. Association between *physical development* of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the crude odds ratios (OR) for a standard deviation increase in the SWPER score.

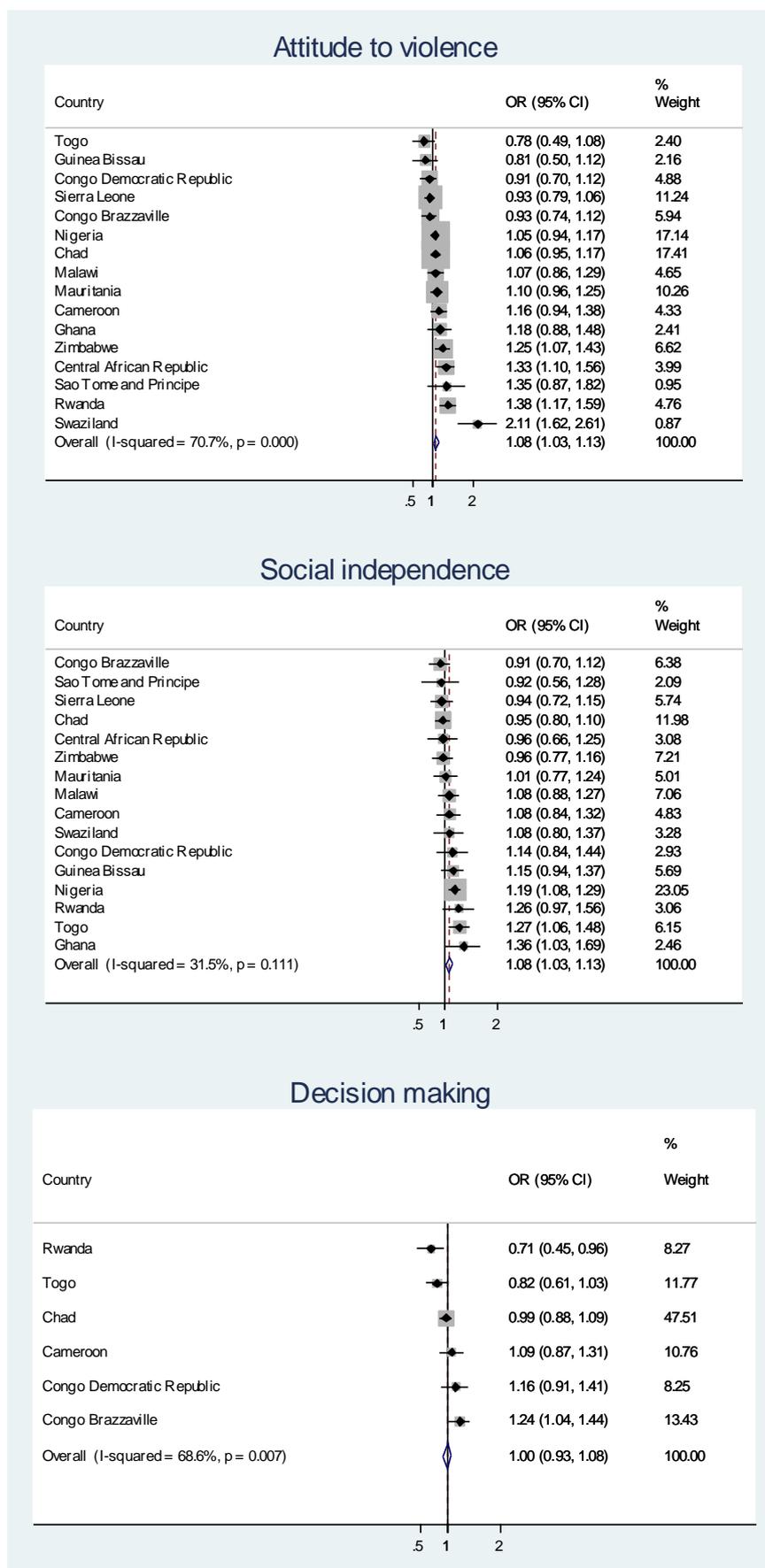


Figure 3. Association between *learning development* of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the crude odds ratios (OR) for a standard deviation increase in the SWPER score.

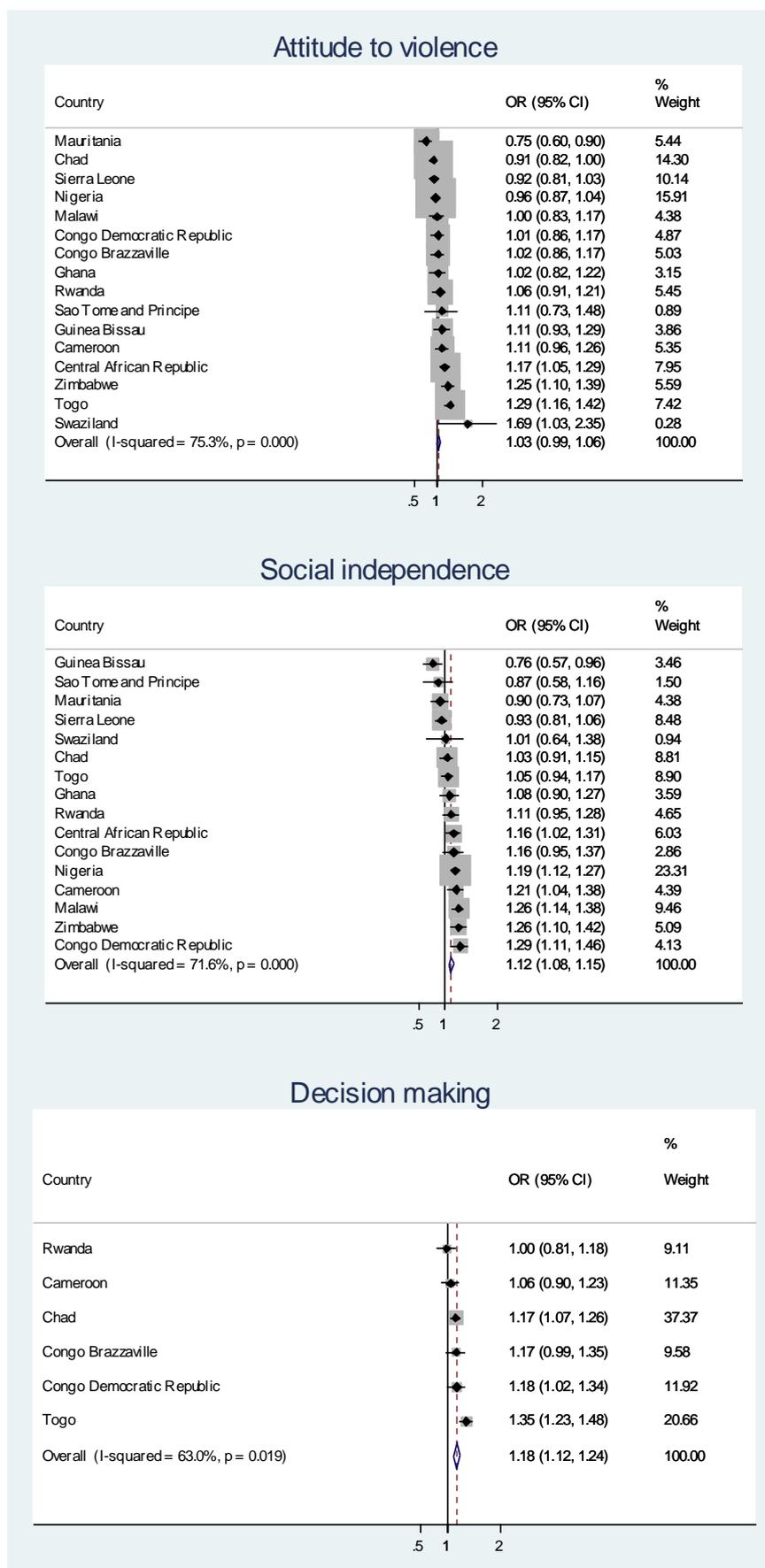
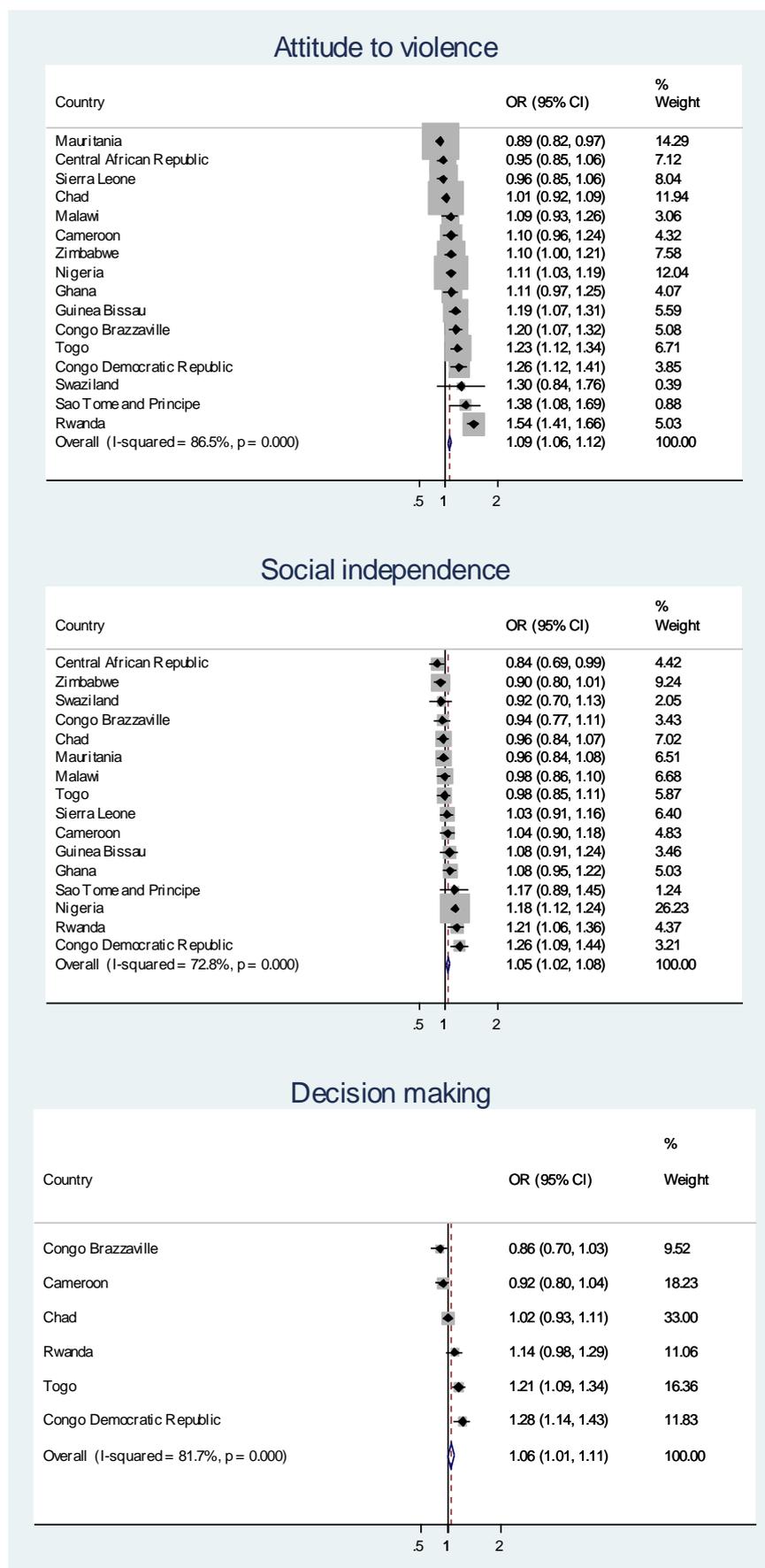


Figure 4. Association between *socio-emotional development* of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the crude odds ratios (OR) for a standard deviation increase in the SWPER score.



Web Appendix

Table A2. Variables used in the development of the survey-based women's empowerment index.

SWPER		
Domain	Variable	Code or unit
Attitude to violence	Beating NOT justified if:	
	1. wife goes out without telling husband	Yes = -1; Don't know=0 ² ; No=1
	2. wife neglects the children	
	3. wife argues with husband	
	4. wife refuses to have sex with husband	
5. wife burns the food		
Social independence	6. Frequency of reading newspaper or magazine	Not at all=0; <once a week=1; ≥once a week=2
	7. Woman education in completed years of schooling	Years
	8. Education difference: woman minus husband completed years of schooling	Years
	9. Age difference: woman age minus husband age	Years
	10. Age at first cohabitation	Years
	11. Age of woman at first birth	Years
Decision making	Who usually decides on:	
	12. Respondent's health care	Husband/other alone= -1; joint=0; respondent alone=1
	13. Large household purchases	
	14. Visits to family or relatives	
	15. Respondent worked in last 12 months	No = 0; In the past year = 1; Have a job, but on leave last 7 days = 2; Currently working = 2

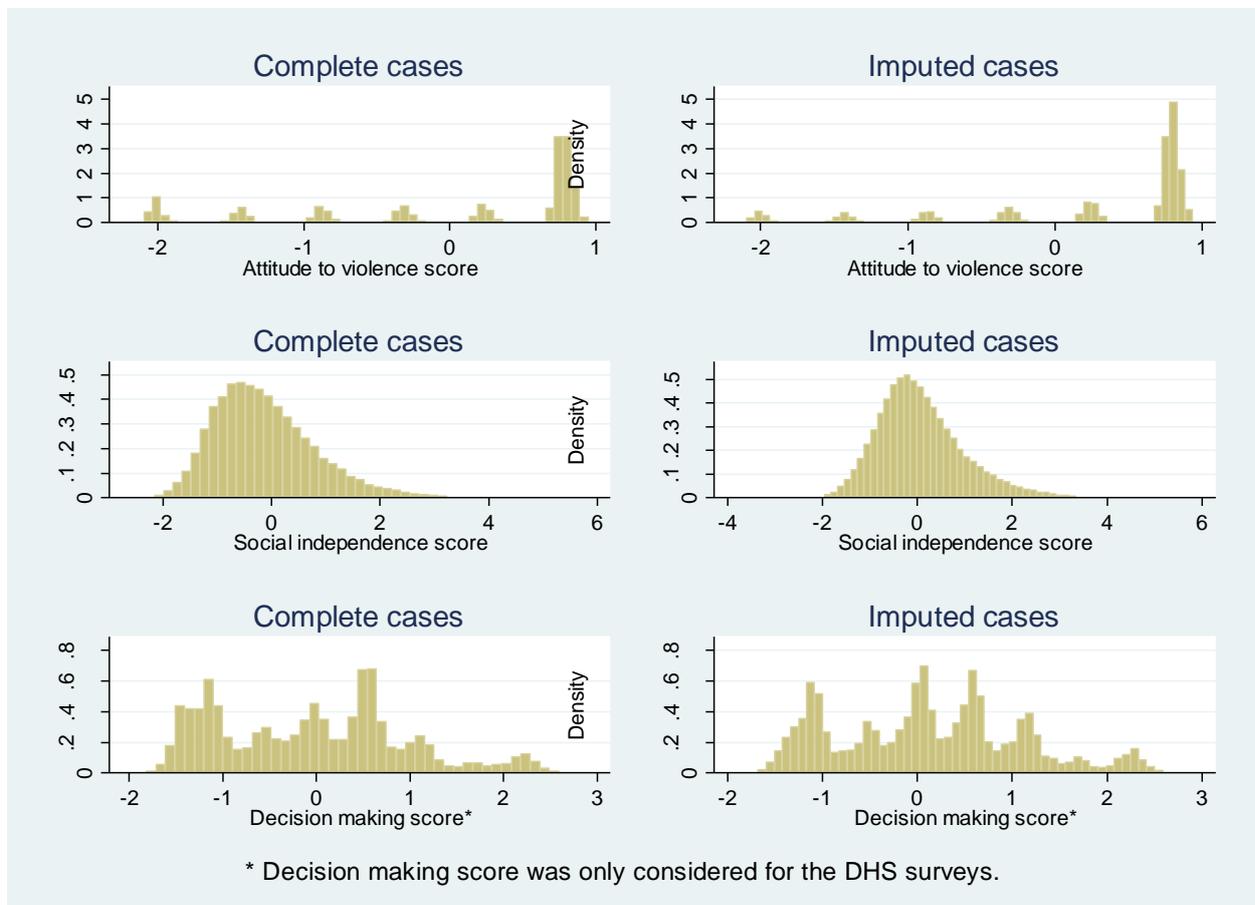
Note: Category "Don't know" was set to missing and imputed as yes or no in the multiple imputation process.

Strategy used to deal with the missing data

Some women did not have complete information on all the items needed to calculate the SWPER scores and some surveys included in this analysis did not collect some variables used for the SWPER. MICS does not provide the husband's education and also does not collect any information on the woman's participation in household decisions. To overcome the husband's education issue, we used the head of the household's years of schooling as a proxy of the husband's education. But to estimate the SWPER scores we had to impute missing data.

We used multiple imputation for these missing variables by design (questions not included in the survey questionnaire) and for those cases where the answers for individual women were missing. We assumed that the data were missing at random. We pooled the data from the 16 countries used in this analysis with data from all the latest DHS from each African country, as these surveys collected information on all the SWPER items (but not on child development). By doing so the imputation model relied on a much larger sample. Thus, multiple imputation was performed in this dataset that contained information on 448,186 women from 40 African countries. In the pooled dataset, 26.6% of the women (n=119,086) had missing information for at least one SWPER item. The literature advocates that five imputed datasets are generally sufficient, but up to 20 datasets are preferable to deal with the sampling variability from the imputation process (15). Given the considerably high proportion of missing cases in our data, we decided to impute 20 datasets. The SWPER items and the outcome of interest (ECDI) with missing information were imputed based on country, wealth index, region and area (urban/rural) of residence, woman's age and the outcome of interest (ECDI). Women in the attitude to violence items women could answer "yes", "no" or "don't know" (see table A1 in the appendix). The latter was also considered as an information in the SWPER, but the proportion of women answering "don't know" in these items was too low (generally <1%), causing the multiple imputation not to converge. Thus, we set this information to missing and the imputation process also imputed information (yes/no) for these items. Figure 1 shows the distribution of the SWPER scores comparing the observations with complete information on the 15 items and the cases with at least one missing item. It shows that the distribution of the empowerment scores with imputed items are very similar to the distribution of the complete cases. For the MICS surveys, the decision-making items were imputed to allow the calculation of the attitude to violence and social independence domains, but the decision-making domain will only be analyzed in the DHS surveys.

Figure A1. Comparison of the SWPER score distribution between complete cases¹ and observations with at least one SWPER item imputed using multiple imputation.



Note: Complete cases are all women with complete information on the 15 items that compose the SWPER Index; imputed cases are the ones with at least one missing item.

Figure A2. Association between *literacy-numeracy* development of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the odds ratios (OR) for a standard deviation increase in the SWPER score adjusted for wealth.

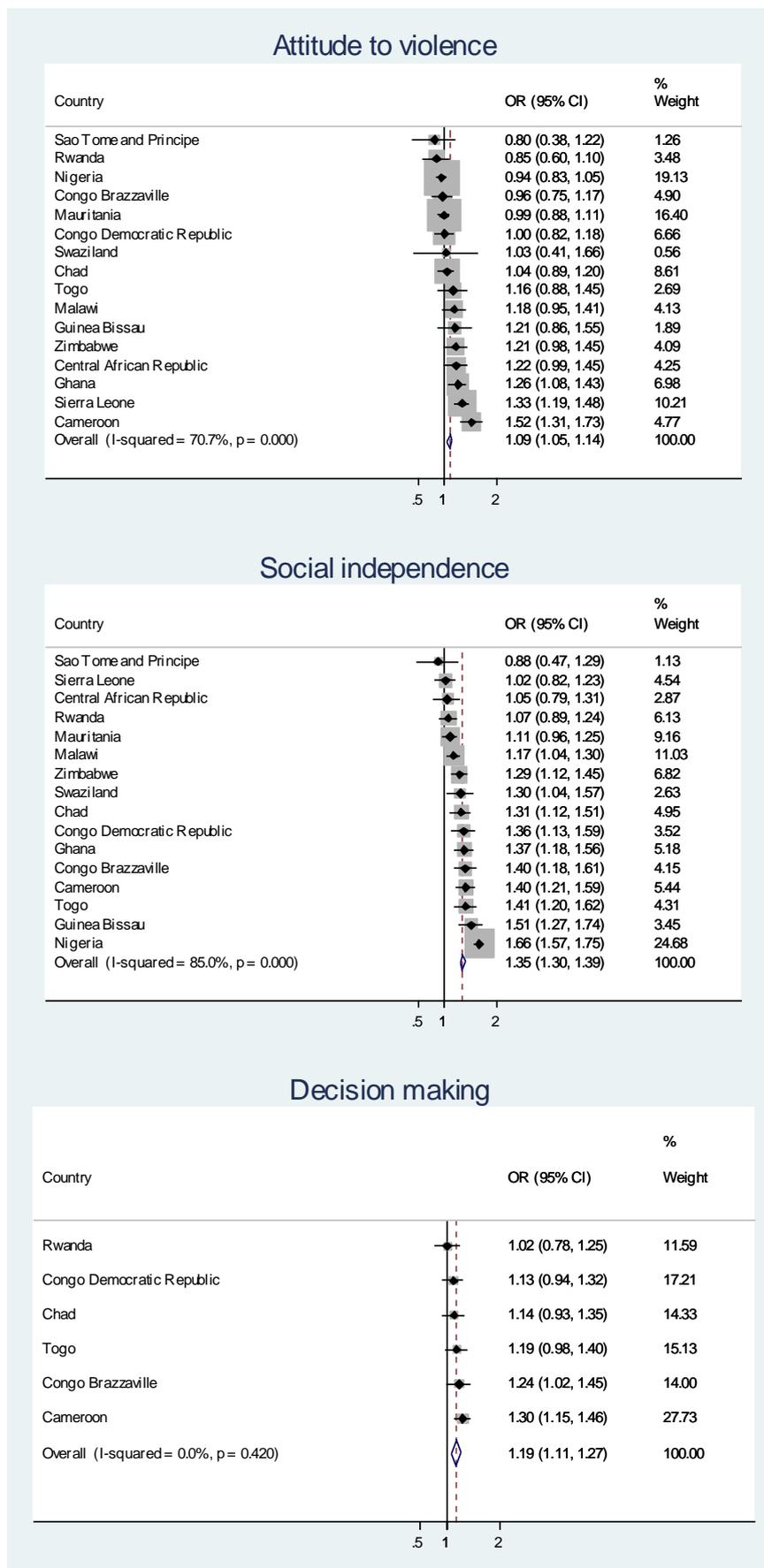


Figure A3. Association between *physical* development of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the odds ratios (OR) for a standard deviation increase in the SWPER score adjusted for wealth.

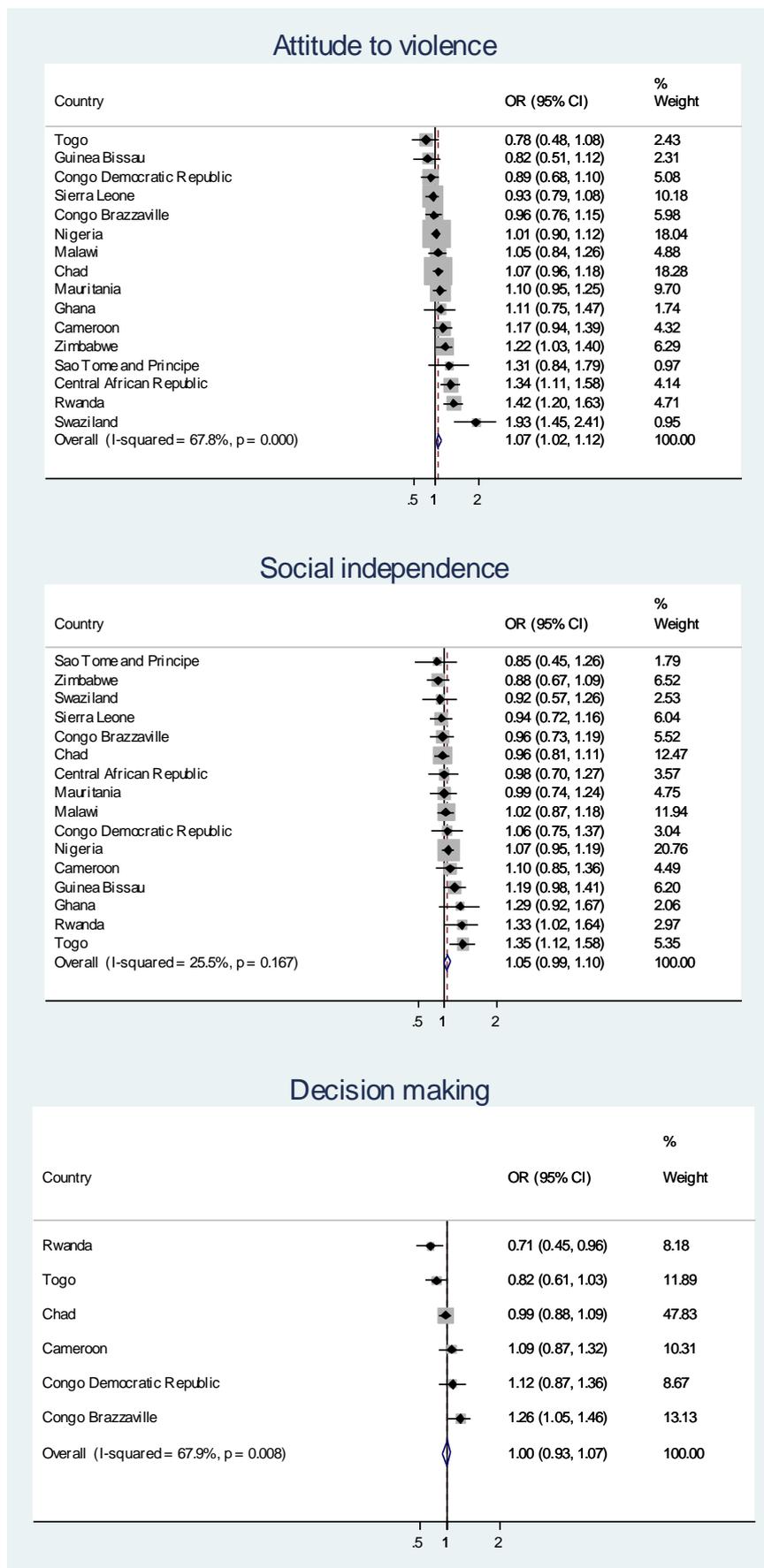


Figure A4. Association between *learning* development of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the odds ratios (OR) for a standard deviation increase in the SWPER score adjusted for wealth.

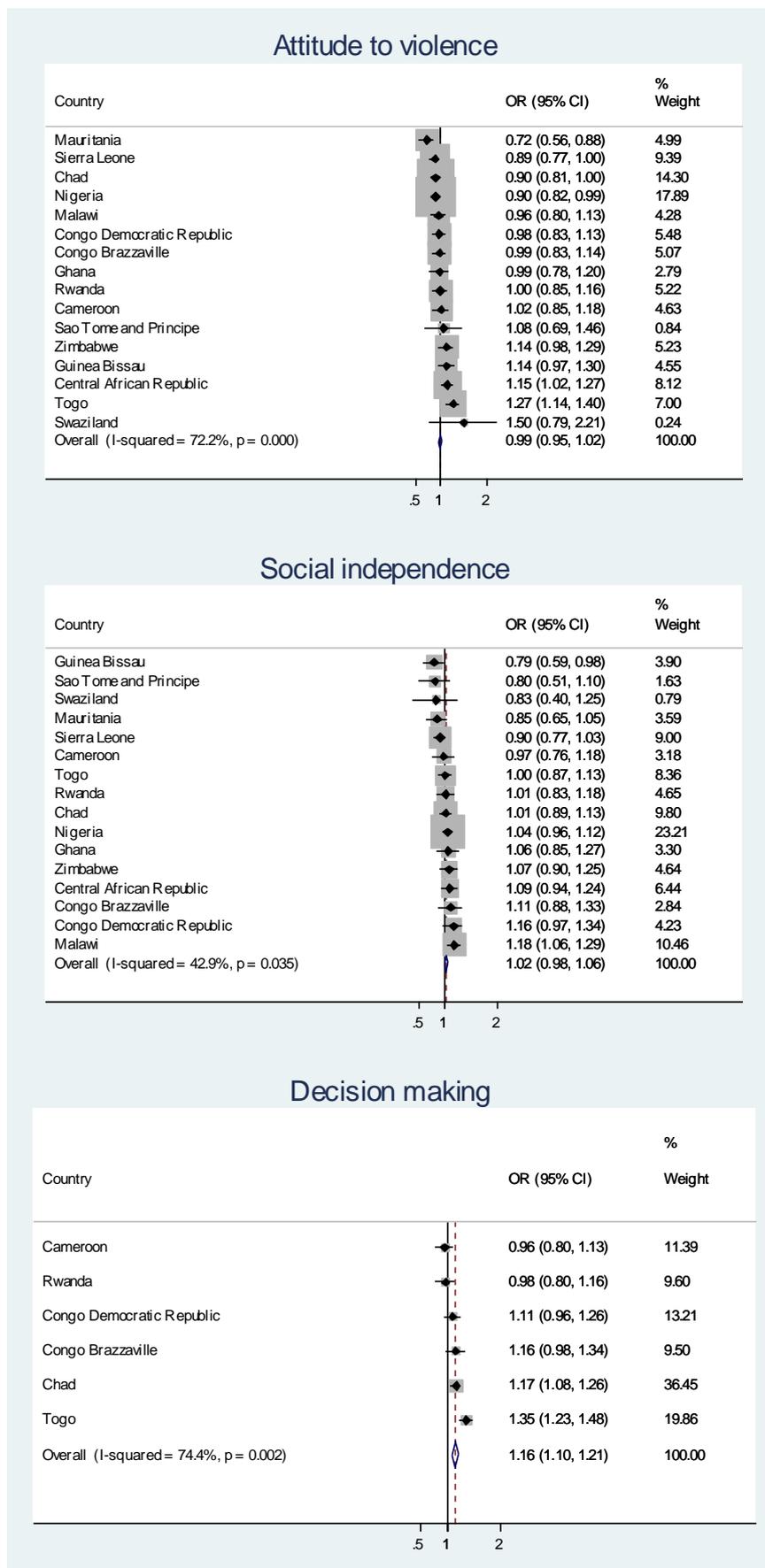


Figure A5. Association between *socio-emotional* development of the child and the mothers' empowerment level for each SWPER domain. Coefficients are the odds ratios (OR) for a standard deviation increase in the SWPER score adjusted for wealth.

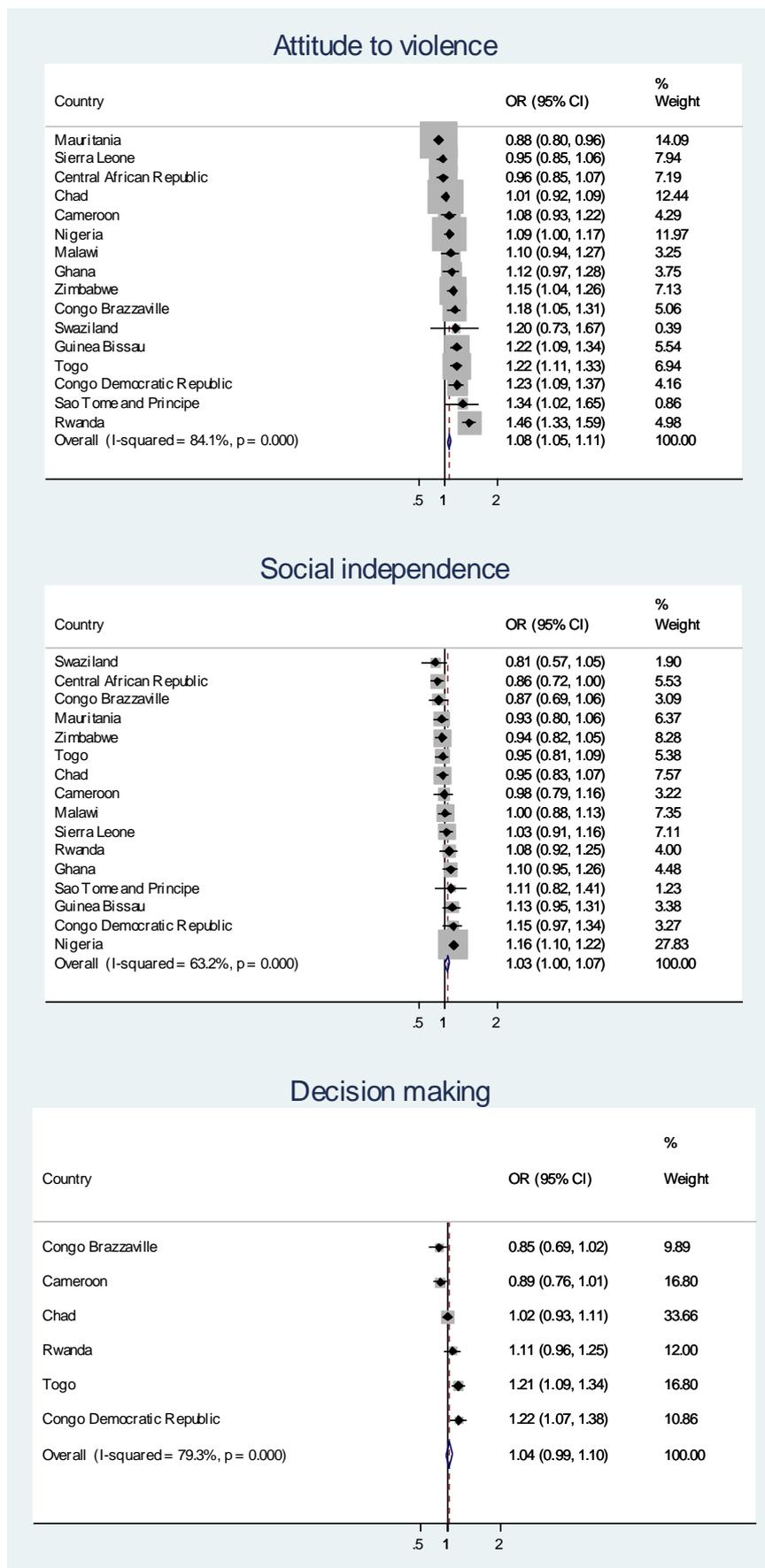


Figure A6. Association between the composite *early childhood development index* and the mothers' empowerment level for each SWPER domain. Coefficients are the crude odds ratios (OR) for a standard deviation increase in the SWPER score.

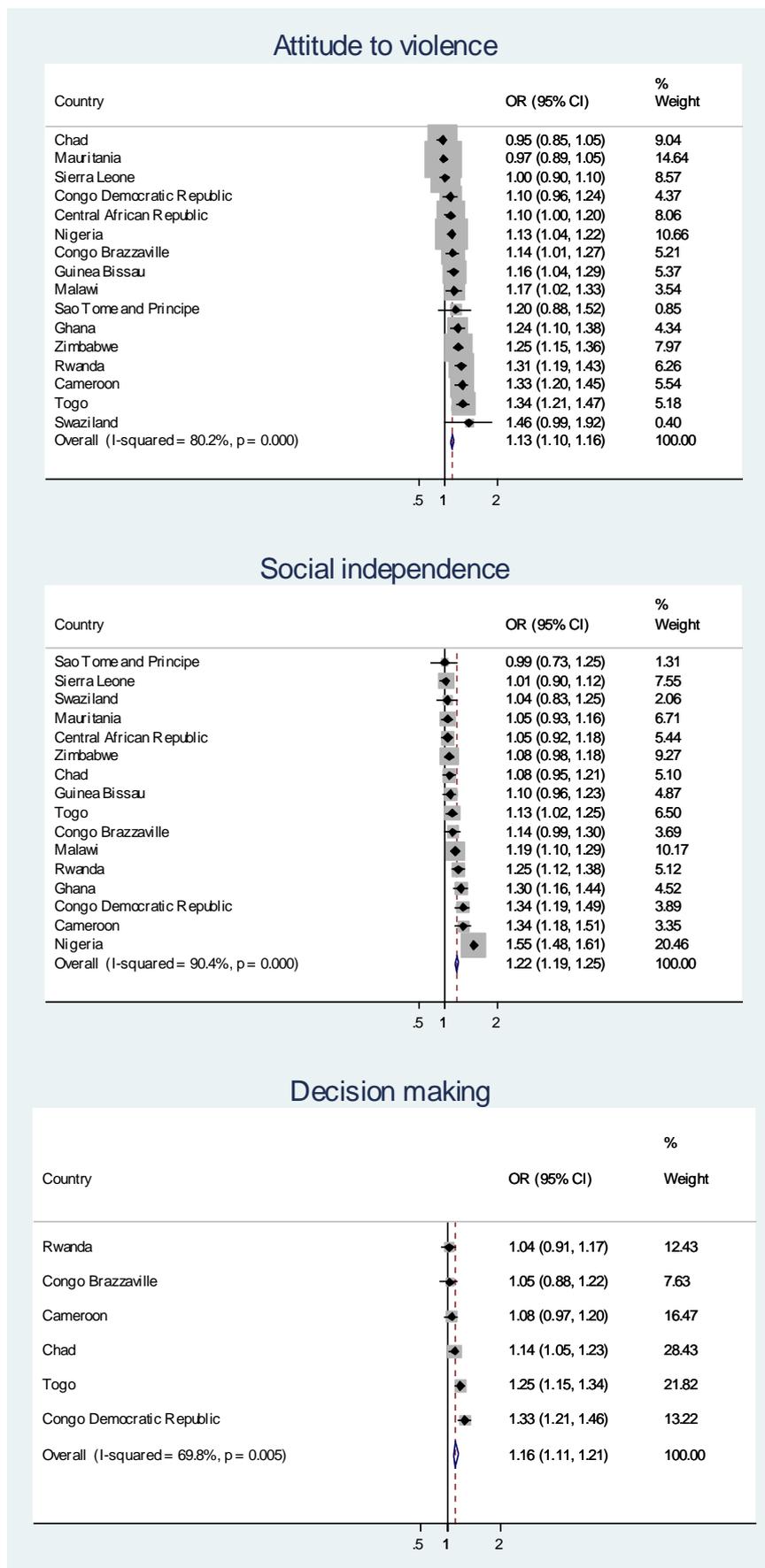
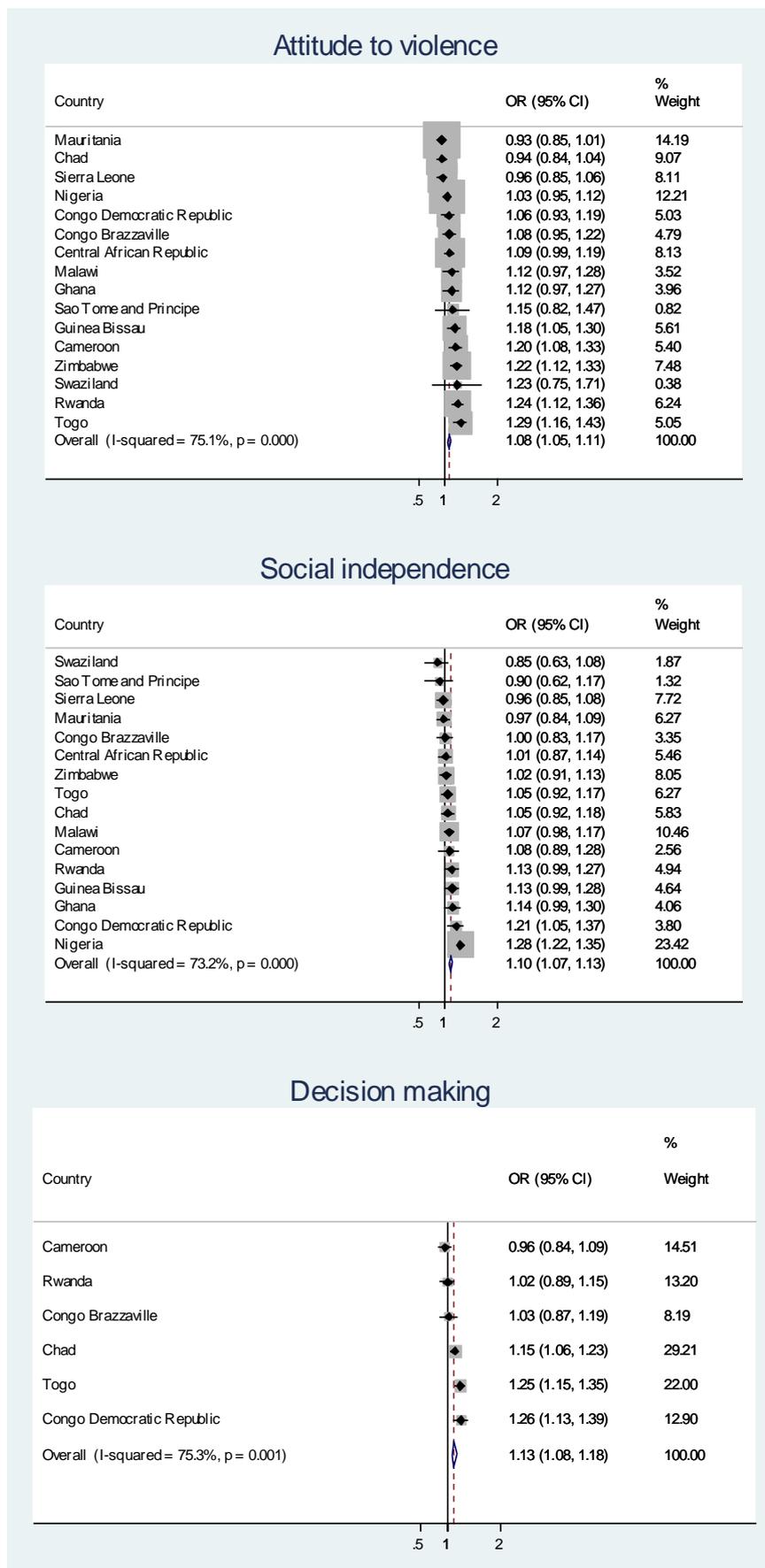


Figure A7. Association between the composite *early childhood development index* and the mothers' empowerment level for each SWPER domain. Coefficients are the odds ratios (OR) for a standard deviation increase in the SWPER score adjusted for wealth.



Press Release

Press release

Empowering women may improve the coverage with maternal and child health interventions

In 2015 the United Nations launched a new set of objectives to guide countries towards sustainable development. Given its potential to promote economic growth, reduce poverty and accomplish human rights, women's empowerment is one of the Sustainable Development Goals.

A study developed at the International Center for Equity in Health, Federal University of Pelotas (Brazil), evaluated the effect of women's empowerment on the coverage with essential reproductive, maternal, newborn and child health (RMNCH) interventions among 36 African countries. The essential interventions evaluated include the demand for family planning satisfied with modern contraceptive methods, antenatal care and skilled birth attendant, vaccination coverage and management of diarrhea and suspected pneumonia among children. The study revealed a strong effect of the countries' empowerment level on their coverage with essential RMNCH interventions, regardless of the countries' GDP. The poorest women are most affected by the association between disempowerment and RMNCH intervention coverage.

"Our findings suggest that efforts toward the achievement of gender equality and the empowerment of women and girls may have important impact on health and health care utilization on the African continent, especially among the poorest women". However, changes in gender relations are hard and slow processes. Jointly with the call for change in gender relations issued by the Sustainable Development Goals, the author hopes that the study will give more prominence to this crucial issue that has been historically neglected. "Universal health coverage will never be achieved with half of the population being socially marginalized", concludes the author.