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RESEARCH ARTICLE

Title: In Sub-Saharan African countries, priority health services should be expanded to unmarried middle aged and older adults: example from Burkina Faso

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Keywords: Indigent; social vulnerability; community-based selection; universal health coverage; high-priority health service.

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ABSTRACT

Background

In Africa, health research on indigent people has focused on how to target them for programs and services, but little research has been conducted to identify the social groups that compose indigence. Our aim was to identify what makes someone indigent beyond being recognized by their community as needing a card for free healthcare.

Methods

We used data from a survey conducted to evaluate a project for performance-based financing of health services in two districts of Burkina Faso. In 2015, we interviewed 2,077 non-indigents and 1,009 people defined as indigents by their community in 20 villages. Using a classification tree, we built a model that made it possible to select socioeconomic and health characteristics that were likely to distinguish between non-indigents and indigents. We described the diagnostic performance of the tree using data from specific nodes.

Results

Widow(er)s under 45 years of age, unmarried people aged 45 years and over, and married women aged 60 years and over were more likely to be identified as indigents by their community. Simple rules based on marital status and gender detected indigents with sensitivity of 75.6% and specificity of 55% among those 45 years and over. Among those under 45, sensitivity was 85.5% and specificity 92.2%. Combining both tests, sensitivity was 78% and specificity 81%.

Conclusion

In its progress toward Universal Health Coverage, Burkina Faso should extend universal access to high-priority healthcare to unmarried people and those 45 years of age and over, and services should be adapted to their health needs.

Ethics consideration

Approval for data collection, storage and release for research purpose has been given by the by an ethics committee of the Government of Burkina Faso approved the study (Decision No. 2013-7-066). Respondent consent was obtained verbally.

ARTICLE SUMMARY

Article focus

To identify what makes someone an indigent beyond being recognized by his or her community as needing a card for free healthcare.

Key messages

- In rural Burkina Faso, indigence was associated with older age, unmarried status and female gender;
- Using Burkina Faso's 2014 Demographic Health Survey data, indigent population in rural areas would represent 1% of those under 45; 23% of those aged 45 and over and 45% of people aged 60 and over;
- Healthcare in Burkina Faso as in many other Sub-Saharan Africa countries should include high-priority services to unmarried middle aged and older adults particularly widow(er)s and older women, and be adapted to their health needs, including chronic diseases.

Strengths and limitations of this study

The strengths of this study are:
To our knowledge, this is the first study that allowed characterizing those who constitute that indigent population in a Sub-Saharan Africa country;

Using an original study method and data from a substantial number of villages in Burkina Faso, we shed light on indigence by providing the characteristics of the indigents. These characteristics combined could identify indigents in rural areas with a sensitivity of 78% and a specificity of 81%.

The limitations of this study:
This study was limited to rural areas in Burkina Faso. More researches are needed to assess if these results could be generalize to urban areas.

INTRODUCTION

Universal health coverage (UHC) has been a key objective for the international community since the call made by the United Nations in 2012. However, given resource constraints, countries must determine their own priorities, and UHC does not mean governments will be able to provide access to all possible health services. High-priority health services should, however, be available to everyone.[1] UHC implementation should follow the path of progressive universalism, which involves initially targeting indigents to support them proportionally to their level of disadvantage and offer them high-priority services.[2] Targeting social benefits in developing countries has proven challenging.[3] More specifically, identifying indigents is a challenge for healthcare sector reform, particularly in Africa,[4] where two processes have been regularly investigated: community-based targeting (CBT) and proxy mean testing (PMT).[5] In 2007, in Burkina Faso, CBT was tested in a rural district. Under health district leadership, village selection committees produced lists of indigents whom they selected based on a consensual definition and with no pre-determined criteria: ''someone who is extremely disadvantaged socially and economically, unable to look after him/herself, and devoid of internal or external resources''. These persons received an official card for free access to healthcare.[6] This CBT was contextually relevant and effective for selecting indigents. Research has shown, however, that user fees exemptions are not enough and more is needed to ensure indigents benefit from services.[7, 8] Moreover, no study has identified who are those in a state of indigence. Are elderly adults protected informally by their extended families, or do they lack adequate resources to spend on healthcare in the absence of formal government safety nets and old age pensions? What access do poor women have to healthcare in societies where men have the decisional power in the family? In a patriarchal society, is being a woman a driver toward indigence?

In this study, our aim was to identify what makes someone an indigent beyond being recognized by his or her community as needing a card for free healthcare.

POPULATION AND METHODS

Setting

An intervention combining performance-based financing (RBF) for healthcare with user fees exemptions for indigents was implemented in 10 districts in Burkina Faso in 2014. It provided increased financing to healthcare structures and staff based on quantity and quality of care provided. Higher fee-for-service rates were offered for some services delivered to indigents.[9] To identify indigents in each district, a CBT process was implemented in villages concerned by the intervention. In each village, a selection committee developed a list of indigents based on their perception of the definition suggested by Ridde et al. [6] This list was validated by an external committee. The World Bank supported the program, paying up to 7.2 times more for some consultations for indigents than for those of non-indigents.

The present study was conducted in 20 villages in two rural districts of Burkina Faso with an agricultural economy: Diébougou (127,857 inhabitants) in the southwest and Gourcy (208,740 inhabitants) in the north. With only four general practitioners and no specialists in both districts, health services use in these areas is very low. In 2014, the average annual number of health visits per inhabitant was 1.03 in Diébougou and 0.73 in Gourcy.[10]

Study sample

Data were collected between February and April 2015, dry season months, when households are more available for interviews than during the agricultural season.

Ten villages were randomly selected in each district; all households that included an indigent as identified by the CBT were included. For comparison, we randomly selected 85% of households without indigence in Diébougou and 45% in Gourcy.

Data were collected on tablets by trained investigators using Open Data Kit (ODK) software. The household questionnaire included modules on household composition, education, assets, and other dimensions. In households including at least one indigent, an individual health questionnaire survey was administered to the indigent member(s). In households without an indigent, an individual member was randomly selected and

administered the same individual health questionnaire. Altogether, 2,077 non-indigents and 1,009 indigents were interviewed in the two districts.

Study variables

Individual-level variables were selected based on health determinants reported in previous studies in Africa:[11-13]

- Demographic characteristics: gender (male, female), age (18–24, 25–34, 35–44, 45–59, 60+), marital status (single, monogamous union or living together, polygamous union, divorced or separated, widowed);

- Socio-economic characteristics: highest level of education (none, primary school, secondary school); engaging in income-producing activity in the past seven days; difficulties satisfying food needs; financial constraints making it difficult to buy food, use the health care centre, or buy medicines;

- Health: self-rated health (poor, not poor); self-reported chronic disease; visual impairment;

- Physical functioning: physical disability; limitations in walking 400 metres; upper limb strength limitations.

Ethics

An ethics committee of the Government of Burkina Faso approved the study (Decision No. 2013-7-066). Respondent consent was obtained verbally.

Data sharing

No additional data available

Statistical methods

Chi-squared tests were used to compare socio-economic characteristics, health status, and physical functioning of non-indigents and indigents.

To create classification models (IBM SPSS Statistics Version 22), we used the IBM SPSS Decision Trees procedure. Classification and regression tree analysis is a non-parametric exploratory method that partitions the sample using explanatory variables so that segments obtained are as homogenous as possible with regard to the dependent variable.[14] Using the Quick Unbiased Efficient Statistical Tree method (QUEST), we built a model that allowed us to select socio-economic, health status, and physical functioning characteristics that were most likely to split non-indigents from indigents. All variables available for this study were specified in the decision tree model. Fourteen were included in the final model procedure: gender, age, highest level of education, marital status, engaging in income-producing activity, financial difficulties (financial constraints making it difficult to buy food or use the health care centre), perceived poor health, chronic disease, visual impairment, disability, ability to walk, and physical strength. Variables that did not contribute significantly were automatically removed from the final model.

The target category was "indigent". For each split, the association between each covariable and the target category was computed using Pearson's chi–square. At each step, the covariable showing the highest association with the target category was selected for splitting.[15] When specifying the model, we set an equal cost of misclassification for non-indigents and indigents, the value of alpha for splitting nodes at 0.05, minimum parent node size at 50, and parent node size at 25. We also performed a sensitivity analysis setting a higher cost of misclassification for indigents (twice that for non-indigents). We randomly split the sample into two subsamples (both including non-indigents and indigents), and the models were fitted using the first as a training sample and then testing on the second subsample. Trees were generated to maximum size,

where each node contained single-class data or no test offered improvement on the mix of classes at that node, then pruned to avoid over-fitting. We also assessed diagnostic performance of the test tree.

RESULTS

Characteristics of the study population

The analysis sample consisted of 1783 (85.8%) non-indigents and 829 (82.2%) indigents aged 18 years and over with complete information. A total of 294 non-indigents' and 180 indigents' questionnaires were incomplete and excluded from analyses.

Of the total sample population, 1,433 (54.9%) lived in Gourcy, 1,555 (59.5%) were women, and 574 (22.0%) were aged 60 years and over. Most were illiterate (2,312, 88.5%); more than one-third (1004, 38.4%) had difficulties satisfying food needs; 12.6% (315) had difficulties walking 400 metres, and 15% (406) perceived their health as poor.

Table 1 presents the study sample characteristics by indigent status. Indigents were more likely to be women, older, illiterate and/or widowed. They were also more likely to be in poor health and to find it financially difficult to cover basic needs.

Classification of non-indigents and indigents

Figure 1 presents the test tree diagram. Age, marital status, gender, upper limb strength limitations, and financial constraints preventing healthcare centre use and purchase of foodstuffs were the best covariates for separating non-indigents from indigents. All p-values for splitting the nodes were below 0.0001.

We used colour codes to represent tree nodes according to proportions of indigents: red (nodes 3, 9 and 15, with proportions of indigents above 75%); orange (nodes 1, 5, 8, 11, 18, 19, proportions between 50% and 75%); yellow (proportions between 25% and 50%), and green for groups with proportions under 25%. Red nodes (3, 9 and 15) could be used as screening tests with high specificity. Since the first partitioning variable, aged 45 years and over, was so strongly associated with indigence, we developed separate screening schemes for those aged 45 years and over and those under 45.

Diagnostic performance

Among those aged 45 and over, two nodes (3 and 15) had high prevalence of indigence. Node 3, which comprised those 45 years and over who were unmarried, contained 150

of the total 332 indigents (45%) in that age group. The sensitivity of "being unmarried" to detect indigence among those 45 years and over was 45% (150/332), and specificity was 83% (218/264). Node 15, married women aged 60 years and over, had a prevalence of indigence of 81.6% and could be used to screen for indigence among those 45 years and over who were married, with sensitivity of 34% (62/182) and specificity of 94% (204/218). By combining nodes 3 and 15, we obtained a test of indigence among those 45 years and over with sensitivity of 64% and specificity of 77%.

Among those under 45, there was only one red node: node 9, being widowed. The sensitivity of "being widowed" for indigence was 66% (55/83), and specificity was 99.2% (610/615). Combining these two screening criteria, for those 45 years and over and those under 45, we obtained sensitivity of 64.3% and specificity of 92.6%.

Sensitivity could be improved, with a compromise in specificity, by including the orange nodes in the screening criteria (Table 2). For those aged 45 years and over, screening for indigence was based on belonging to node 3 (unmarried men and women aged 45 and over) or node 8 (married women aged 45 and over) with sensitivity of 75.6% (251/332) and specificity of 55% (145/264). Among those under 45, screening could be based on belonging to node 5 (unmarried and under 45) or node 11 (under 45 with upper limb strength limitations), with sensitivity of 85.5% (71/83) and specificity of 92.2% (567/615).

In summary, using simple rules based on easy-to-obtain indicators of marital status and gender, we were able to detect about 75.6% of indigent subjects among people aged 45 years and over with specificity of 55%, and 85.5% of indigent subjects among those under 45, with specificity of 92.2%. Combining both tests, we obtained overall sensitivity of 78% and specificity of 81%.

Indigence was largely restricted to being old and unmarried. Indeed, the frequency of indigence among young people (<45 years) who were married or living with a partner was only 4.3%.

Goodness of fit of the classification tree was evaluated by the index value and the gains and index charts. The index value of the model was above 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. Risk

of misclassification was 14.8%. Overall percentage of correct classification was 85.2%. The sensitivity analysis presented in Appendix 1 confirmed that age, gender, and marital status were strongly correlated with indigence.

DISCUSSION

Using survey data on individuals in 20 villages of two districts in Burkina Faso, we used classification and regression tree methodology to identify best predictors of indigence, as defined by the community. Results showed that being aged 45 years and over, unmarried, and/or a woman were strong predictors of being identified as indigents. Using simple rules based only on easy-to-obtain indicators of marital status and gender, we were able to detect three-quarters of indigents among those aged 45 years and over and six out of seven indigents among those under 45.

Population aging has emerged as a major demographic trend even in low-income countries like Burkina Faso, posing challenges to social institutions.[16] With a population estimated at 17.59 million in 2014 and a poverty headcount ratio of 46.7%, Burkina Faso is one of the poorest countries in the world. Life expectancy has increased in recent years, estimated at 58 years for males and 59 for females in 2013.[17] To our knowledge, in middle- and low-income countries like Burkina Faso, despite increases in the older adult population generating a greater burden of chronic conditions,[18] social and health policies to adapt to the changing age structure are rare. McEniry and McDermott [19] describe low-income countries like Burkina Faso as countries where mortality declined rapidly very late in the 20th century. However, in these countries, the health of older cohorts is shaped by survivorship of poor early-life conditions, resulting in early onset of chronic diseases and high prevalence of frailty. Our study showed that aging leads to both poor health and deprivation in Burkina Faso. Roth,[20] studying intergenerational relations in Burkina Faso, reported that strength, energy, and therefore the opportunity to earn one's keep decreased with age. Those who cannot participate in reciprocal exchanges of gifts or services risk social marginalization. Yet with no social security [21] and without exchange relations, there is no social recognition.

Our study also revealed unmarried people were more likely to be indigents. As marriage in Africa marks the transition to adulthood, single persons are not recognized as adults able to assume responsibilities.[20] Marriage confers status and dignity,[22] providing individuals with a sense of meaning and of obligation to others, while inhibiting risky behaviours and encouraging healthy ones.[23] Previous studies have reported that single, divorced, or bereaved persons showed higher mortality and morbidity in specific

diseases,[24, 25] as well as lower quality of life [26] compared with those who were married or cohabiting. The differences between married and unmarried people may reflect not only a causal effect of marriage but also a selection effect: healthier people may be more likely than others to find mates and marry.[27]

Widows across the globe share two common experiences: loss of social status and reduced economic circumstances.[28] In developed countries, widowhood is experienced primarily by elderly women, while in developing countries it also affects younger women, many of whom are still rearing children. Widowers, even when elderly, are far more likely to remarry,[29] but this is not the case for widows, who, if they do remarry, rarely do so of their own free will. As a result, many women spend a long period of their lives in widowhood, with all its associated disadvantages and stigmas.[28] In Burkina Faso, the sociocultural context is still marked by beliefs and practices leading to discrimination against women, particularly older women, including widow inheritance, forced marriage, and social exclusion of women for witchcraft allegations. Belief in witchcraft is more dominant in rural areas, where poverty usually leads to strained human and in-law relations, and where most illnesses cannot be explained.[30] Women victims of such violence and discrimination are mostly seniors, have had not children or only girls, have emigrated, or their children have not "succeeded". They are widowed or postmenopausal, poor, and uneducated.[31] In our study, women who were indigents were likely to carry health consequences of their reproductive history. After surviving adolescent childbirth and multiparity, they were at high risk of lower physical performance,[32] chronic diseases, incontinence [33] or fistula.[34] Supporting this line of evidence, Doulougou et al. [29] reported that widows in Burkina Faso were more vulnerable to hypertension than married women of similar age, education and health behaviours.

The classification tree showed that even married women, if aged 60 years and over, were more likely to be indigents. Power inequalities in gender relationships, affecting access to resources and decision-making on sexual and reproductive issues, are frequent in West African societies.[35] Harmful cultural practices, such as widow cleansing, son preference, and others, remain threats to women's health and well-being.[36] Onadja et al. reported that being a woman was positively associated with higher odds of cognitive

impairment and mobility disability in Burkina Faso, and the size of associations appeared insensitive to adjustment for various life-course socioeconomic and health conditions.[37] Females make up an increasing proportion of the world's poor.[38] This situation is exacerbated by age and marital status, as shown in this research.

Policy implications

The way the state is organized often exacerbates existing social cleavages, intensifying inequalities between rich and poor. For many vulnerable groups, such as older adults, unmarried adults, and widowed women, changes over the past decade have eroded important social safety networks and practices.[39] Targeting the poorest for free access to healthcare or financial assistance has emerged as an alternative to UHC in many developing countries. Such targeting requires effective selection strategies. Our results show that three groups compose the indigent population in Burkina Faso: widow(er)s under 45, unmarried people aged 45 years and over, and married women aged 60 years and over. Using the country's 2014 Demographic Health Survey data, we selected and described these groups and found they represented 1% of the total population under 45, 23% of those aged 45 and over, and 45% of people aged 60 and over.

In its progress toward UHC, the government of Burkina Faso has implemented, since April 2, 2016, free access to maternal and child healthcare. However, as reported here, there are other vulnerable groups with poor health and limited access to health services. Healthcare in Burkina Faso should include high-priority services to unmarried people and those aged 45 years and over (like in Senegal, where elderly people have free access to healthcare),[40] particularly widow(er)s and older women, and be adapted to their health needs, including chronic diseases.

Conclusion

Using an original study method, this study sheds light on indigence by providing the characteristics of indigents as perceived by their own communities. Indigence is rare among the married population under 45 and frequent among unmarried adults and older adults, particularly widows(er)s and older women. Indigent people reported poorer health, chronic disease, and limitations in physical functioning. This implies that

patient-centred healthcare for indigent people must take into account age and gender and the management of chronic conditions.

AUTHORS' CONTRIBUTIONS

Samiratou Ouédraogo performed the statistical analysis, interpreted the results, reviewed the literature, and prepared the manuscript.

Valéry Ridde was involved in conception of the study design, data collection, statistical analysis, interpretation of results, literature review, and manuscript preparation.

Nicole Atchessi was involved in conception of the study design, data collection, and manuscript preparation.

Aurélia Souares was involved in conception of the study design, data collection, and manuscript preparation.

Jean-Louis Koulidiati was involved in conception of the study design, data collection, and manuscript preparation.

Quentin Stoeffler participated in conception of the study design, data collection, and manuscript preparation.

Zunzunegui Maria-Victoria was involved in conception of the study design, statistical analysis, interpretation of results, literature review, and manuscript preparation.

All authors read and approved the final manuscript.

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The funding body did not play any role in study design; analysis; interpretation of data; writing of the manuscript and the decision to submit it for publication.

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COMPETING INTERESTS

We declare that we have no conflicts of interest.

TABLES

Table 1: Comparison of socio-economic characteristics and health status between non-indigents and indigents

Variables	Total Number	Non-indigents		Indigents		P value
		Number	Percentage	Number	Percentage	
		1783		**829**		
District						<0.0001
Diébougou	1179	631	35.4	548	66.1	
Gourcy	1433	1152	64.6	281	33.9	
Gender						<0.0001
Male	1057	802	45.0	255	30.8	
Female	1555	981	55.0	574	69.2	
Age (years)						<0.0001
18–24	368	364	20.4	4	0.5	
25–34	555	524	29.4	31	3.7	
35–44	457	328	18.4	129	15.6	
45–59	658	333	18.4	325	39.2	
60+	574	234	13.1	340	41.0	
Highest level of education achieved						<0.0001
None	2312	1522	85.4	790	95.3	

Primary school	213	188	10.5	25	3.0	
Secondary school	87	73	4.1	14	1.7	
Marital status						<0.0001
Single	111	68	3.8	43	5.2	
Monogamous union or living together	1308	1035	58.0	273	32.9	
Polygamous union	715	562	31.5	153	18.5	
Divorced or separated	25	8	0.4	17	2.1	
Widowed	453	110	6.2	343	41.4	
Engaged in income-producing activity in the past 7 days						<0.0001
No	2044	1344	75.4	700	84.4	
Yes	568	439	24.6	129	15.6	
Difficulties satisfying food needs						<0.0001
No	1608	1219	68.4	389	46.9	
Yes	1004	564	31.6	440	53.1	
Financial difficulties that prevent buying foodstuffs						<0.0001
No	1561	1210	67.9	351	42.3	
Yes	1051	573	32.1	478	57.7	

Financial difficulties that prevent going to the healthcare centre						<0.0001
No	1553	1250	70.1	303	36.6	
Yes	1059	533	29.9	526	63.4	
Financial difficulties that prevent buying medicines						<0.0001
No	1610	1280	71.8	330	39.8	
Yes	1002	503	28.2	499	60.2	
Perceived poor health						<0.0001
No	2206	1629	91.4	577	69.6	
Yes	406	154	8.6	252	30.4	
Chronic disease						<0.0001
No	1592	1243	69.7	349	42.1	
Yes	1020	540	30.3	480	57.9	
Disability						<0.0001
No	2297	1679	94.2	618	74.5	
Yes	315	104	5.8	211	25.5	
Perceived limitations in ability to walk 400m						<0.0001
No	2366	1702	95.5	664	80.1	

Yes	246	81	4.5	165	19.9	
Perceived limitations in upper limb strength						<0.0001
No	2282	1697	95.2	585	70.6	
Yes	330	86	4.8	244	29.4	
Visual impairment						0.4
No	2560	1745	97.9	815	98.3	
Yes	52	38	2.1	14	1.7	

Table 2: Diagnostic performance of the test tree

Characteristics	Test tree nodes	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Under 45	Red node (9)	0.66 (55/83)	0.99 (610/615)	0.92 (55/60)	0.96 (610/638)
	Red and orange nodes (5, 11)	0.86 (71/83)	0.92 (567/615)	0.60 (71/119)	0.98 (567/579)
45 years of age and over	Red nodes (3, 15)	0.64 (212/332)	0.77 (204/264)	0.78 (212/272)	0.63 (204/324)
	Red and orange nodes (3, 8)	0.76 (251/332)	0.55 (145/264)	0.68 (251/370)	0.64 (145/226)
All ages	Red nodes (3, 9, 15)	0.64 (267/415)	0.93 (814/879)	0.80 (267/332)	0.85 (814/962)
	Red and orange nodes (3, 5, 8, 11)	0.78 (322/415)	0.81 (712/879)	0.66 (322/489)	0.88 (712/805)

Data are percentages, with numbers of patients in parentheses:

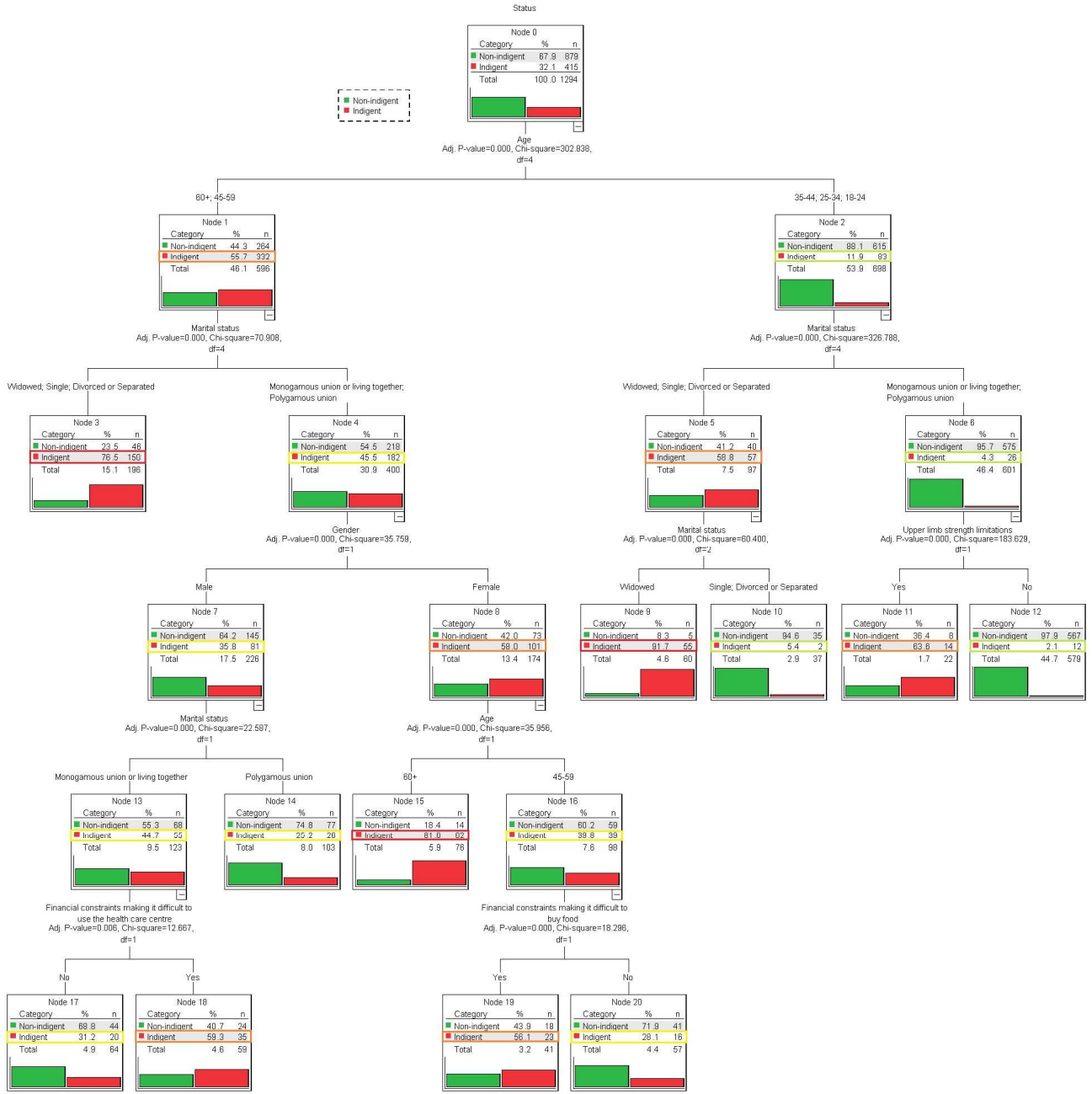
- Sensitivity in under 45 was 66% (red node) = (Total indigents in node 9) / (Total indigents in this age group; node 2) x 100;

- Specificity in all ages was 81% (red and orange nodes) = [(Total non-indigents in node 1) – (Total non-indigents in nodes 3 and 8)] + [(Total non-indigents in node 2) – (Total non-indigents in nodes 5 and 11)] / total non-indigents in all ages groups (nodes 1 and 2) x 100;

- Positive predictive value in all ages was 80% (red nodes 3, 9, and 15) = (Total indigents in red nodes 3, 9, and 15) / (Total non-indigent and indigents in red nodes 3, 9, and 15) x 100.

- Negative predictive value in under 45 was 98% (red and orange nodes) = [(Total non-indigents in node 2) – (Total non-indigents in nodes 5 and 11)] / [(Total indigents in node 2 – Total indigents in nodes 5 and 11) + (Total non-indigents in node 2 – Total non-indigents in nodes 5 and 11)] x 100.

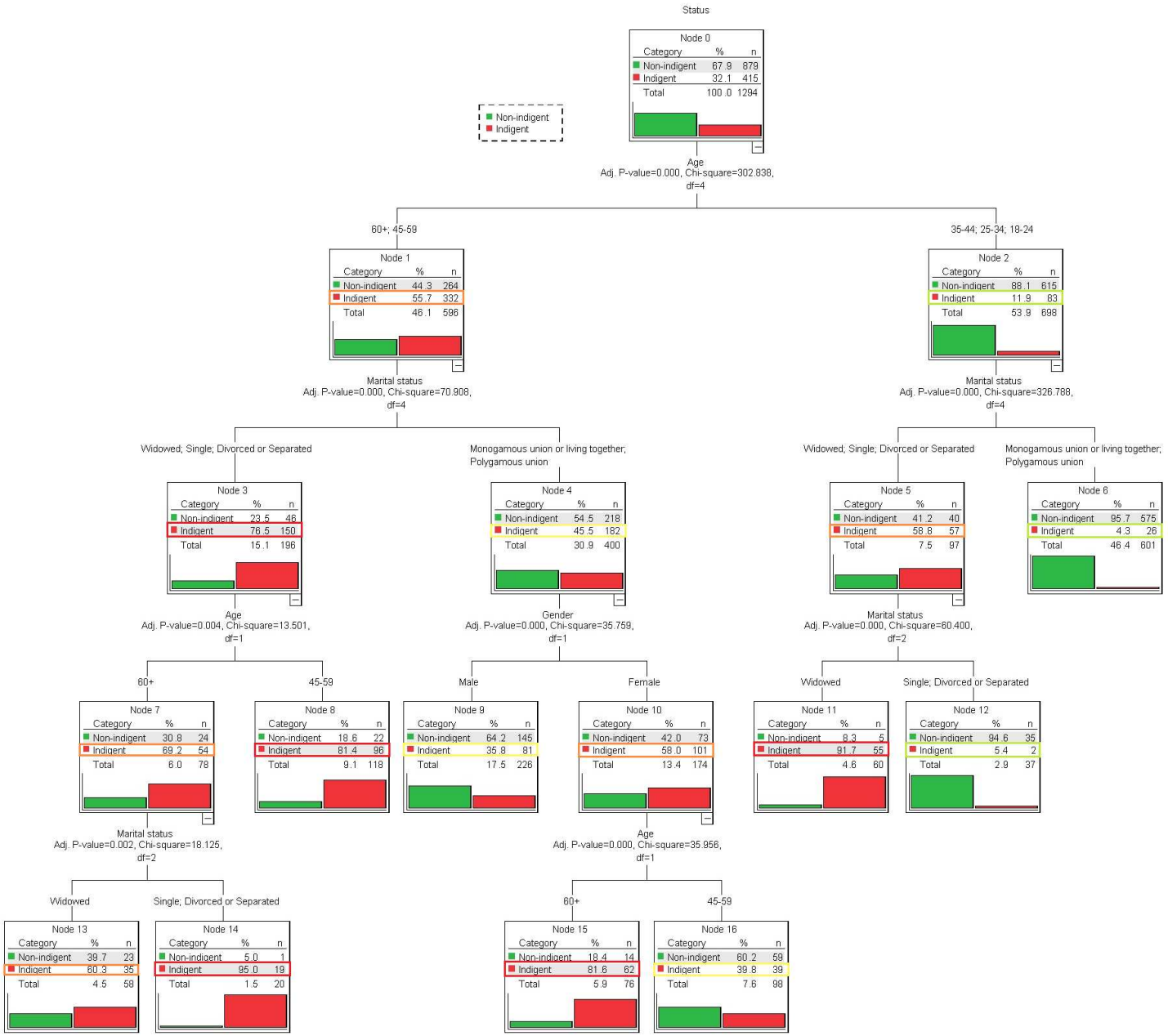
FIGURE 1



APPENDIX 1

Results of the test tree, where the cost of misclassifying indigents as non-indigents was set to be twice the cost of misclassifying non-indigents as indigents. The value of alpha for splitting nodes was set at 0·05, minimum parent node size at 50, and parent node size at 25.

The index value and the gains and index charts indicate the classification was good. The index value of the model was greater than 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. The risk of misclassification was 20·9%. The overall percentage of correct classification was 83·4%, and 86·5% of indigents were accurately classified by the model.



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Characterisation of rural indigent population in Burkina Faso: A helpful screening tool for setting priority health care services in Sub-Saharan African

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RESEARCH ARTICLE

Title: **Characterisation of rural indigent population in Burkina Faso: A helpful screening tool for setting priority health care services in Sub-Saharan African**

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ABSTRACT

Background

In Africa, health research on indigent people has focused on how to target them for services, but little research has been conducted to identify the social groups that compose indigence. Our aim was to identify what makes someone indigent beyond being recognized by the community as needing a card for free health care.

Methods

We used data from a survey conducted to evaluate a State-led intervention for performance-based financing of health services in two districts of Burkina Faso. In 2015, we interviewed 2,077 non-indigents and 1,009 people defined as indigents by their community in 20 villages following a community-based targeting process. Using a classification tree, we built a model that made it possible to select socioeconomic and health characteristics that were likely to distinguish between non-indigents and indigents. We described the screening performance of the tree using data from specific nodes.

Results

Widow(er)s under 45 years of age, unmarried people aged 45 years and over, and married women aged 60 years and over were more likely to be identified as indigents by their community. Simple rules based on age, marital status, gender detected indigents with sensitivity of 75.6% and specificity of 55% among those 45 years and over; among those under 45, sensitivity was 85.5% and specificity 92.2%. Combining both tests, sensitivity was 78% and specificity 81%.

Conclusion

In its progress toward Universal Health Coverage, Burkina Faso should extend free access to priority health care services to unmarried people and women aged 60 years and over, and services should be adapted to their health needs.

Ethics consideration

Approval for data collection, storage and release for research purpose has been given by an ethics committee of the Government of Burkina Faso (Decision No. 2013-7-066). Respondent consent was obtained verbally.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To our knowledge, this is the first published study that identified those who constitute an indigent population in a Sub-Saharan Africa country;
- The results of the study provide the local authorities in Burkina Faso useful information on populations that need urgent health care coverage;
- This study was limited to certain rural areas in Burkina Faso, further research is needed to assess if these results could be generalize to urban areas;
- Due to lack of data, we could not perform comparative analyses of the characteristics of people with and without missing data in the study.

INTRODUCTION

Universal health coverage (UHC) has been a key objective for the international community since the call made by the United Nations in 2012. However, given resource constraints, countries must determine their own priorities, and UHC does not mean governments will be able to provide access to all possible health services. High-priority health services should, however, be available to everyone.[1] UHC implementation could follow the path of progressive universalism, which involves initially targeting indigents to support them proportionally to their level of disadvantage and offer them high-priority services.[2] Targeting social benefits in developing countries has proven challenging.[3, 4] More specifically, identifying indigents is a challenge for health care sector reform, particularly in Africa,[5, 6] where two processes have been regularly investigated: community-based targeting (CBT) and proxy mean testing (PMT).[7, 8] Unlike PMT, there are few studies on CBT in Sub-Saharan Africa. A discussion around these two approaches is beyond the scope of the article. We intend to characterise the subgroup of population that constitute the worst off selected through a community-based targeting approach. In 2007, in Burkina Faso, CBT was tested in a rural district, then in two urban districts and in the National Capital. Under health district leadership, village selection committees produced lists of indigents whom they selected based on a consensual definition and with no pre-determined criteria: ‘‘someone who is extremely disadvantaged socially and economically, unable to look after him/herself, and devoid of internal or external resources’’. These persons received an official card for free access to health care.[9] This CBT was contextually relevant and effective for selecting indigents. However they have also shown, that user fees exemptions are not enough and more is needed to ensure indigents benefit from services.[10] Moreover, no study has identified who are those in a state of indigence. Are elderly adults protected informally by their extended families, or do they lack adequate resources to spend on health care in the absence of formal government safety nets and old age pensions? What access do poor women have to health care in societies where men have the decisional power in the family? In a patriarchal society, is being a woman a driver toward indigence?

In this study, our aim was to identify what makes someone an indigent beyond being recognized by his or her community as needing a card for free health care.

POPULATION AND METHODS

Setting

An State-led intervention combining performance-based financing (RBF) for health care with user fees exemptions for indigents was implemented in 10 districts in Burkina Faso in 2014. It provided increased financing to health care structures and staff based on quantity and quality of care provided. Higher fee-for-service rates were offered for some services delivered to indigents.[11] To identify indigents in each district, a CBT process was implemented in villages concerned by the intervention. In each village, a selection committee developed a list of indigents based on their perception of the definition suggested by Ridde et al.[8] This list was validated by an external committee. The World Bank financed this State led program, paying up to 7.2 times more for some consultations for indigents than for those of non-indigents.

In the present study, a community-based selection approach was used to identify the indigents. The study was conducted in 20 villages in two rural districts of Burkina Faso with an agricultural economy: Diébougou (127,857 inhabitants) in the southwest and Gourcy (208,740 inhabitants) in the north. With only four general practitioners and no specialists in both districts, health services use in these areas is very low. In 2014, the average annual number of health visits per inhabitant was 1.03 in Diébougou and 0.73 in Gourcy.[12] These districts are different in terms of agricultural practices, weather conditions and ethnic composition. They therefore represent a diversity of rural contexts in Burkina Faso.

Study sample

Data were collected between February and April 2015, dry season months, when households are more available for interviews than during the agricultural season.

Ten villages were randomly selected in each district; all households that included an indigent as identified by the CBT were included. For comparison, we randomly selected 85% of households without indigence in Diébougou and 45% in Gourcy.

Data were collected on tablets by trained investigators using Open Data Kit (ODK) software. The household questionnaire included modules on household composition,

education, assets, and other dimensions. In households including at least one indigent, an individual health questionnaire survey was administered to the indigent member(s). In households without an indigent, an individual member was randomly selected and administered the same individual health questionnaire. Altogether, 2,077 non-indigents and 1,009 indigents were interviewed in the two districts.

Study variables

Individual-level variables were selected based on health determinants reported in previous studies in Africa:[13-15]

- Demographic characteristics: gender (male, female), age (18–24, 25–34, 35–44, 45–59, 60+), marital status (single, monogamous union or living together, polygamous union, divorced or separated, widowed);

- Socio-economic characteristics: highest level of education (none, primary school, secondary school); engaging in income-producing activity in the past seven days; difficulties satisfying food needs; financial constraints making it difficult to buy food, use the health care centre, or buy medicines;

- Health: self-rated health (poor, not poor); self-reported chronic disease; visual impairment;

- Physical functioning: physical disability; limitations in walking 400 metres; upper limb strength limitations.

Ethics

An ethics committee of the Government of Burkina Faso approved the study (Decision No. 2013-7-066). Respondent consent was obtained verbally.

Data sharing

No additional data available.

Statistical methods

Chi-squared tests were used to compare socio-economic characteristics, health status, and physical functioning of non-indigents and indigents.

To create classification models (IBM SPSS Statistics Version 22), we used the IBM SPSS Decision Trees procedure. Classification and regression tree analysis is a non-parametric exploratory method that partitions the sample using explanatory variables so that segments obtained are as homogenous as possible with regard to the dependent variable.[16] Using the Quick Unbiased Efficient Statistical Tree method (QUEST), we built a model that allowed us to select socio-economic, health status, and physical functioning characteristics that were most likely to split non-indigents from indigents. All variables available for this study were specified in the decision tree model. Fourteen were included in the final model procedure: gender, age, highest level of education, marital status, engaging in income-producing activity, financial difficulties (financial constraints making it difficult to buy food or use the health care centre), perceived poor health, chronic disease, visual impairment, disability, ability to walk, and physical strength. Variables that did not contribute significantly were automatically removed from the final model.

The target category was "indigent". For each split, the association between each covariable and the target category was computed using Pearson's chi–square. At each step, the covariable showing the highest association with the target category was selected for splitting.[17] When specifying the model, we set an equal cost of misclassification for non-indigents and indigents, the value of alpha for splitting nodes at 0.05, minimum parent node size at 50, and parent node size at 25. We also performed a sensitivity analysis setting a higher cost of misclassification for indigents (twice that for non-indigents). We randomly split the sample into two subsamples (both including non-indigents and indigents), and the models were fitted using the first as a training sample and then testing on the second subsample. Trees were generated to maximum size,

where each node contained single-class data or no test offered improvement on the mix of classes at that node, then pruned to avoid over-fitting. We also assessed screening performance of the test tree, using the community-based selection of the indigents as the gold standard.

RESULTS

Characteristics of the study population

The analysis sample consisted of 1783 (85.8%) non-indigents and 829 (82.2%) indigents aged 18 years and over with complete information. A total of 294 non-indigents' and 180 indigents' questionnaires were incomplete and excluded from analyses.

Of the total sample population, 1,433 (54.9%) lived in Gourcy, 1,555 (59.5%) were women, and 574 (22.0%) were aged 60 years and over. Most were illiterate (2,312, 88.5%); more than one-third (1004, 38.4%) had difficulties satisfying food needs; 9.4% (246) had difficulties walking 400 metres, and 15.5% (406) perceived their health as poor.

Table 1 presents the study sample characteristics by indigent status. Indigents were more likely to be women, older, illiterate and/or widowed. They were also more likely to be in poor health and to find it financially difficult to cover basic needs.

Classification of non-indigents and indigents

Figure 1 presents the test tree diagram. Age, marital status, gender, upper limb strength limitations, and financial constraints preventing healthcare centre use and purchase of foodstuffs were the best covariates for separating non-indigents from indigents. All p-values for splitting the nodes were below 0.0001.

We used colour codes to represent tree nodes according to proportions of indigents: red (nodes 3, 9 and 15, with proportions of indigents above 75%); orange (nodes 1, 5, 8, 11, 18, 19, proportions between 50% and 75%); yellow (proportions between 25% and 50%), and green for groups with proportions under 25%. Red nodes (3, 9 and 15) could be used as screening tests with high specificity. Since the first partitioning variable, aged 45 years and over, was so strongly associated with indigence, we developed separate screening schemes for those aged 45 years and over and those under 45.

Screening performance of the classification tree

Among those aged 45 and over, two nodes (3 and 15) had high prevalence of indigence. Node 3, which comprised those 45 years and over who were unmarried, contained 150 of the total 332 indigents (45%) in that age group. The sensitivity of "being unmarried" to detect indigence among those 45 years and over was 45% (150/332), and specificity was 83% (218/264). Node 15, married women aged 60 years and over, had a prevalence of indigence of 81.6% and could be used to screen for indigence among those 45 years and over who were married, with sensitivity of 34% (62/182) and specificity of 94% (204/218). By combining nodes 3 and 15, we obtained a test of indigence among those 45 years and over with sensitivity of 64% and specificity of 77%.

Among those under 45, there was only one red node: node 9, being widowed. The sensitivity of "being widowed" for indigence was 66% (55/83), and specificity was 99.2% (610/615). Combining these two screening criteria, for those 45 years and over and those under 45, we obtained sensitivity of 64.3% and specificity of 92.6%.

Sensitivity could be improved, with a compromise in specificity, by including the orange nodes in the screening criteria (Table 2). For those aged 45 years and over, screening for indigence was based on belonging to node 3 (unmarried men and women aged 45 and over) or node 8 (married women aged 45 and over) with sensitivity of 75.6% (251/332) and specificity of 55% (145/264). Among those under 45, screening could be based on belonging to node 5 (unmarried and under 45) or node 11 (under 45 with upper limb strength limitations), with sensitivity of 85.5% (71/83) and specificity of 92.2% (567/615).

In summary, using simple rules based on easy-to-obtain indicators of marital status and gender, we were able to detect about 75.6% of indigent subjects among people aged 45 years and over with specificity of 55%, and 85.5% of indigent subjects among those under 45, with specificity of 92.2%. Combining both tests, we obtained overall sensitivity of 78% and specificity of 81%.

Indigence was largely restricted to being old and unmarried. Indeed, the frequency of indigence among young people (<45 years) who were married or living with a partner was only 4.3%.

Goodness of fit of the classification tree was evaluated by the index value and the gains and index charts. The index value of the model was above 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. Risk of misclassification was 14.8%. Overall percentage of correct classification was 85.2%. The sensitivity analysis presented in Appendix 1 confirmed that age, gender, and marital status were strongly correlated with indigence.

DISCUSSION

Using survey data on individuals in 20 villages of two rural districts in Burkina Faso, we used classification and regression tree methodology to identify best indicators of indigence, as defined by the community. Results showed that being aged 45 years and over, unmarried, and/or a woman were strong indicators of being an indigent, according to the community-based definition. Using simple rules based only on easy-to-obtain indicators of age, marital status and gender, we were able to detect three-quarters of indigents among those aged 45 years and over and six out of seven indigents among those under 45.

Population aging has emerged as a major demographic trend even in low-income countries like Burkina Faso, posing challenges to social institutions.[18] With a population estimated at 17.59 million in 2014 and a poverty headcount ratio of 46.7%, Burkina Faso is one of the poorest countries in the world. Life expectancy has increased in recent years, estimated at 58 years for males and 59 for females in 2013.[19] To our knowledge, in middle- and low-income countries like Burkina Faso, despite increases in the older adult population generating a greater burden of chronic conditions,[20] social and health policies to adapt to the changing age structure are rare. McEniry and McDermott [21] describe low-income countries like Burkina Faso as countries where mortality declined rapidly very late in the 20th century. However, in these countries, the health of older cohorts is shaped by survivorship of poor early-life conditions, resulting in early onset of chronic diseases and high prevalence of frailty. Our study showed that aging leads to both poor health and deprivation in Burkina Faso. Roth,[22] studying intergenerational relations in Burkina Faso, reported that strength, energy, and therefore the opportunity to earn one's keep decreased with age. Those who cannot participate in reciprocal exchanges of gifts or services risk social marginalization. Yet with no social security[14, 23] and without exchange relations, there is no social recognition.

Our study also revealed unmarried people were more likely to be indigents. As marriage in Africa marks the transition to adulthood, single persons are not recognized as adults able to assume responsibilities.[22] Marriage confers status and dignity,[24] providing individuals with a sense of meaning and of obligation to others, while inhibiting risky

behaviours and encouraging healthy ones.[25] Previous studies have reported that single, divorced, or bereaved persons showed higher mortality and morbidity in specific diseases,[26, 27] as well as lower quality of life[28] compared with those who were married or cohabiting. The differences between married and unmarried people may reflect not only a causal effect of marriage but also a selection effect: healthier people may be more likely than others to find mates and marry.[29]

Widows across the globe share two common experiences: loss of social status and reduced economic circumstances.[30] In developed countries, widowhood is experienced primarily by elderly women, while in developing countries it also affects younger women, many of whom are still rearing children. Widowers, even when elderly, are far more likely to remarry,[31] but this is not the case for widows, who, if they do remarry, rarely do so of their own free will. As a result, many women spend a long period of their lives in widowhood, with all its associated disadvantages and stigmas.[30] In fact, the association between widowhood and being in the poorest household wealth quintile was consistent across countries (China, Ghana, India, the Russian Federation and South Africa).[32] In Burkina Faso, the sociocultural context is still marked by beliefs and practices leading to discrimination against women, particularly older women, including widow inheritance, forced marriage, and social exclusion of women for witchcraft allegations. Belief in witchcraft is more dominant in rural areas, where poverty usually leads to strained human and in-law relations, and where most illnesses cannot be explained.[33] Women victims of such violence and discrimination are mostly seniors, have had no children or only girls, have emigrated, or their children have not "succeeded". They are widowed or postmenopausal, poor, and uneducated.[34] In our study, women who were indigents were likely to carry health consequences of their reproductive history. After surviving adolescent childbirth and multiparity, they were at high risk of lower physical performance,[35] chronic diseases, incontinence [36] or fistula.[37] Supporting this line of evidence, Doulougou et al. [31] reported that widows in Burkina Faso were more vulnerable to hypertension than married women of similar age, education and health behaviours.

The classification tree showed that even married women, if aged 60 years and over, were more likely to be indigents. Power inequalities in gender relationships, affecting

access to resources and decision-making on sexual and reproductive issues, are frequent in West African societies.[38] Harmful cultural practices, such as widow cleansing, son preference, and others, remain threats to women's health and well-being.[39] Onadja et al. reported that being a woman was positively associated with higher odds of cognitive impairment and mobility disability in Burkina Faso, and the size of associations appeared insensitive to adjustment for various life-course socioeconomic and health conditions.[40] Females make up an increasing proportion of the world's poor.[41] This situation is exacerbated by age and marital status, as shown in this research.

Potential limitations of this study include the fact that the results may not be representative to urban areas in Burkina Faso because the study targeted only certain rural areas. Moreover, self-reported health included in this study may say more about health awareness, health expectations and overall life satisfaction than about health per se, especially in a poor population with little engagement with services.

Policy implications

The way the State is organized often exacerbates existing social cleavages, intensifying inequalities between rich and poor. For many vulnerable groups, such as older adults, unmarried adults, and widowed women, changes over the past decade have eroded important social safety networks and practices. Targeting the poorest for free access to health care or financial assistance has emerged as an alternative to UHC in many developing countries. Such targeting requires effective selection strategies. Our results show that, following a CBT process, three groups compose the indigent population in rural Burkina Faso: widow(er)s under 45, unmarried people aged 45 years and over, and married women aged 60 years and over. Using the country's 2014 Demographic Health Survey data, we selected and described these groups and found they represented 1% of the total population under 45, 23% of those aged 45 and over, and 45% of people aged 60 and over. Impact and/or cost-effectiveness analyses are needed to confirm that our policy suggestions could be implemented. The ability for the local government to support and sustain these programs must also be assessed.

In its progress toward UHC, the government of Burkina Faso has implemented, since April 2, 2016, free access to maternal and child health care. However, as reported here,

there are other vulnerable groups with poor health and limited access to health services. Health care in Burkina Faso should include high-priority services to unmarried people and those aged 45 years and over (like in Senegal, where elderly people have free access to health care),[42] particularly widow(er)s and older women, and be adapted to their health needs, including chronic diseases. Extending free access to health care services to these vulnerable populations living in the rural areas may be a pertinent public health intervention.

Conclusion

Using an original study method, this research sheds light on indigence by providing the characteristics of indigents as perceived by their own communities. Indigence is rare among the married population under 45 and frequent among unmarried adults and older adults, particularly widows(er)s and older women. Indigent people reported poorer health, chronic disease, and limitations in physical functioning. This implies that patient-centred health care for indigent people must take into account age and gender, and the management of chronic conditions.

AUTHORS' CONTRIBUTIONS

Samiratou Ouédraogo performed the statistical analysis, interpreted the results, reviewed the literature, and prepared the manuscript.

Valéry Ridde was involved in conception of the study design, data collection, statistical analysis, interpretation of results, literature review, and manuscript preparation.

Nicole Atchessi was involved in conception of the study design, data collection, and manuscript preparation.

Aurélia Souares was involved in conception of the study design, data collection, and manuscript preparation.

Jean-Louis Koulidiati was involved in conception of the study design, data collection, and manuscript preparation.

Quentin Stoeffler participated in conception of the study design, data collection, and manuscript preparation.

Zunzunegui Maria-Victoria was involved in conception of the study design, statistical analysis, interpretation of results, literature review, and manuscript preparation.

All authors read and approved the final manuscript.

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The funding body did not play any role in study design; analysis; interpretation of data; writing of the manuscript and the decision to submit it for publication.

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COMPETING INTERESTS

We declare that we have no conflicts of interest.

TABLES

Table 1: Comparison of socio-economic characteristics and health status between non-indigents and indigents

Variables	Total Number	Non-indigents		Indigents		P value
		Number	Percentage	Number	Percentage	
		1783		**829**		
District						<0.0001
Diébougou	1179	631	35.4	548	66.1	
Gourcy	1433	1152	64.6	281	33.9	
Gender						<0.0001
Male	1057	802	45.0	255	30.8	
Female	1555	981	55.0	574	69.2	
Age (years)						<0.0001
18–24	368	364	20.4	4	0.5	
25–34	555	524	29.4	31	3.7	
35–44	457	328	18.4	129	15.6	
45–59	658	333	18.4	325	39.2	
60+	574	234	13.1	340	41.0	
Highest level of education achieved						<0.0001
None	2312	1522	85.4	790	95.3	

Primary school	213	188	10.5	25	3.0	
Secondary school	87	73	4.1	14	1.7	
Marital status						<0.0001
Single	111	68	3.8	43	5.2	
Monogamous union or living together	1308	1035	58.0	273	32.9	
Polygamous union	715	562	31.5	153	18.5	
Divorced or separated	25	8	0.4	17	2.1	
Widowed	453	110	6.2	343	41.4	
Engaged in income-producing activity in the past 7 days						<0.0001
No	2044	1344	75.4	700	84.4	
Yes	568	439	24.6	129	15.6	
Difficulties satisfying food needs						<0.0001
No	1608	1219	68.4	389	46.9	
Yes	1004	564	31.6	440	53.1	
Financial difficulties that prevent buying foodstuffs						<0.0001
No	1561	1210	67.9	351	42.3	
Yes	1051	573	32.1	478	57.7	

Financial difficulties that prevent going to the health care centre						<0.0001
No	1553	1250	70.1	303	36.6	
Yes	1059	533	29.9	526	63.4	
Financial difficulties that prevent buying medicines						<0.0001
No	1610	1280	71.8	330	39.8	
Yes	1002	503	28.2	499	60.2	
Perceived poor health						<0.0001
No	2206	1629	91.4	577	69.6	
Yes	406	154	8.6	252	30.4	
Chronic disease						<0.0001
No	1592	1243	69.7	349	42.1	
Yes	1020	540	30.3	480	57.9	
Disability						<0.0001
No	2297	1679	94.2	618	74.5	
Yes	315	104	5.8	211	25.5	
Perceived limitations in ability to walk 400m						<0.0001
No	2366	1702	95.5	664	80.1	

Yes	246	81	4.5	165	19.9	
Perceived limitations in upper limb strength						<0.0001
No	2282	1697	95.2	585	70.6	
Yes	330	86	4.8	244	29.4	
Visual impairment						0.4
No	2560	1745	97.9	815	98.3	
Yes	52	38	2.1	14	1.7	

Table 2: Screening performance of the test tree

Characteristics	Test tree nodes	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Under 45	Red node (9)	0.66 (55/83)	0.99 (610/615)	0.92 (55/60)	0.96 (610/638)
	Red and orange nodes (5, 11)	0.86 (71/83)	0.92 (567/615)	0.60 (71/119)	0.98 (567/579)
45 years of age and over	Red nodes (3, 15)	0.64 (212/332)	0.77 (204/264)	0.78 (212/272)	0.63 (204/324)
	Red and orange nodes (3, 8)	0.76 (251/332)	0.55 (145/264)	0.68 (251/370)	0.64 (145/226)
All ages	Red nodes (3, 9, 15)	0.64 (267/415)	0.93 (814/879)	0.80 (267/332)	0.85 (814/962)
	Red and orange nodes (3, 5, 8, 11)	0.78 (322/415)	0.81 (712/879)	0.66 (322/489)	0.88 (712/805)

Data are percentages, with numbers of patients in parentheses:

- Sensitivity in under 45 was 66% (red node) = (Total indigents in node 9) / (Total indigents in this age group; node 2) x 100;

- Specificity in all ages was 81% (red and orange nodes) = [(Total non-indigents in node 1) – (Total non-indigents in nodes 3 and 8)] + [(Total non-indigents in node 2) – (Total non-indigents in nodes 5 and 11)] / total non-indigents in all ages groups (nodes 1 and 2) x 100;

- Positive predictive value in all ages was 80% (red nodes 3, 9, and 15) = (Total indigents in red nodes 3, 9, and 15) / (Total non-indigent and indigents in red nodes 3, 9, and 15) x 100.

- Negative predictive value in under 45 was 98% (red and orange nodes) = [(Total non-indigents in node 2) – (Total non-indigents in nodes 5 and 11)] / [(Total indigents in node 2 – Total indigents in nodes 5 and 11) + (Total non-indigents in node 2 – Total non-indigents in nodes 5 and 11)] x 100.

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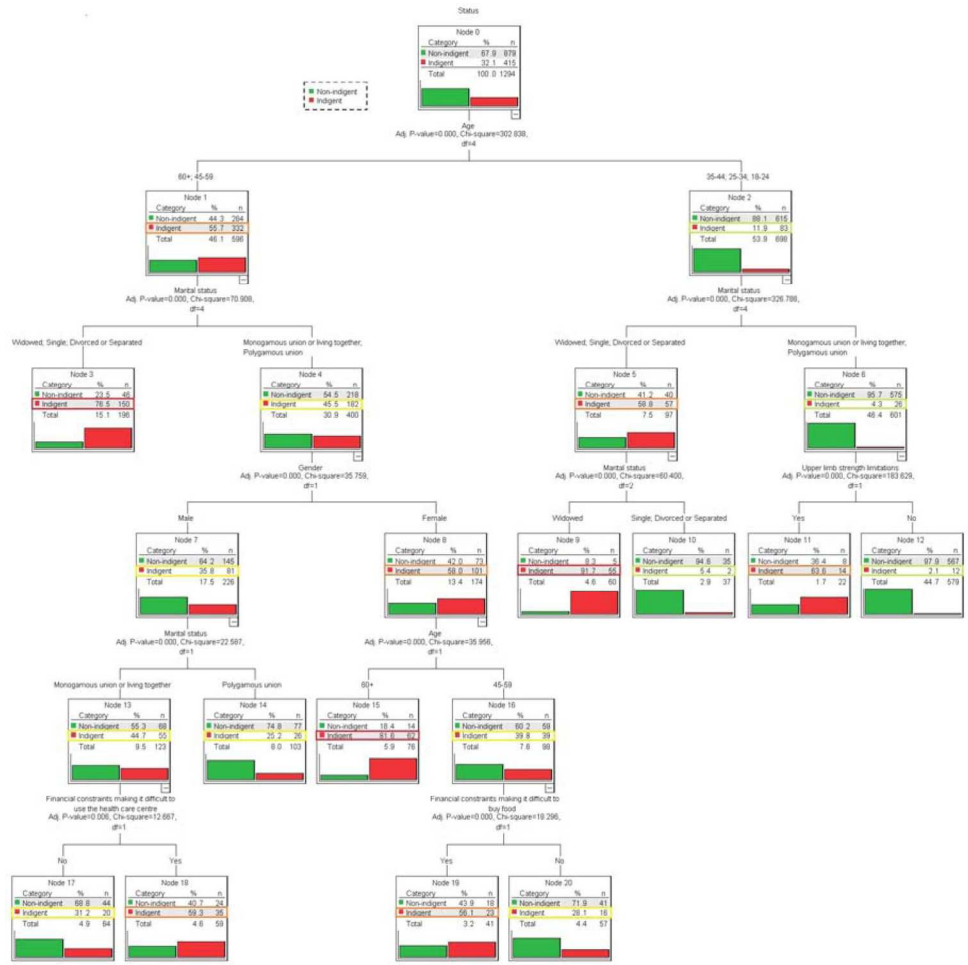


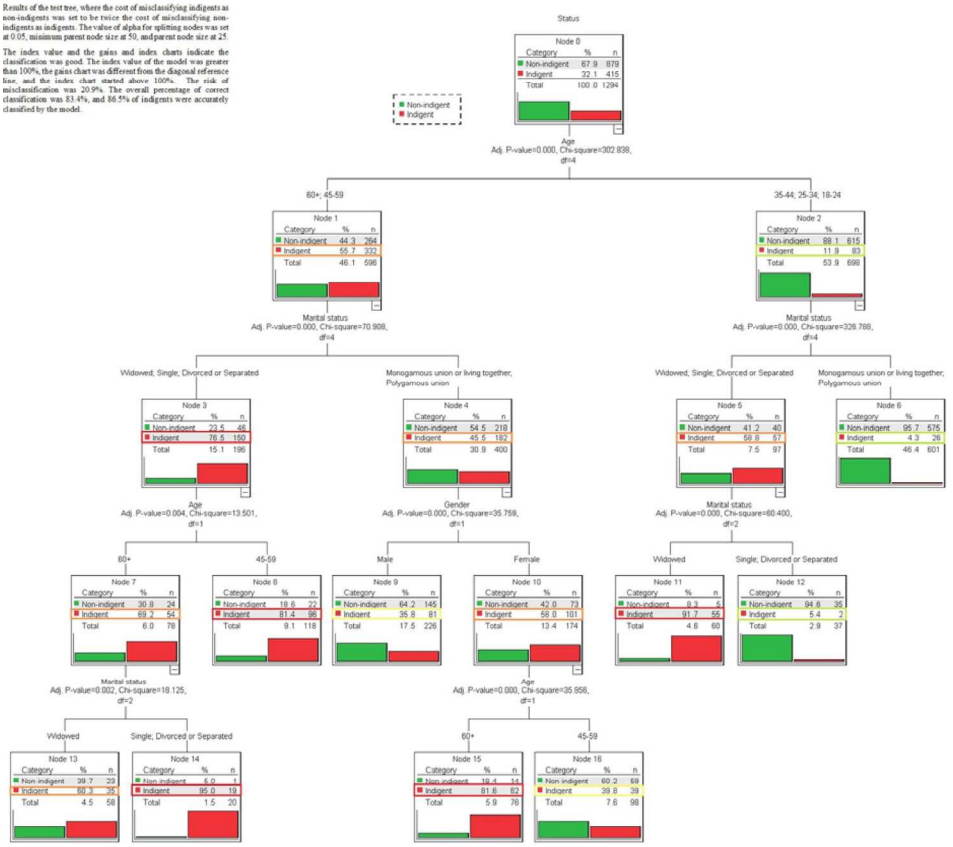
Test tree diagram

159x162mm (300 x 300 DPI)

APPENDIX 1: sensitivity analysis

Results of the test tree, where the cost of misclassifying indigents as non-indigents was set to be twice the cost of misclassifying non-indigents as indigents. The value of alpha for splitting nodes was set at 0.05, minimum parent node size at 50, and parent node size at 25.

The index value and the gains and index charts indicate the classification was good. The index value of the model was greater than 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. The risk of misclassification was 20.9%. The overall percentage of correct classification was 83.4%, and 86.5% of indigents were accurately classified by the model.



Sensitivity analysis

159x143mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement).	7

		Describe comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	12 & 28
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10

		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	21
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	10 & 11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

BMJ Open

Characterization of the rural indigent population in Burkina Faso: a screening tool for setting priority health care services in sub-Saharan Africa

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RESEARCH ARTICLE

Title: **Characterization of the rural indigent population in Burkina Faso: a screening tool for setting priority health care services in sub-Saharan Africa.**

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ABSTRACT

Background

In Africa, health research on indigent people has focused on how to target them for services, but little research has been conducted to identify the social groups that compose indigence. Our aim was to identify what makes someone indigent beyond being recognized by the community as needing a card for free health care.

Methods

We used data from a survey conducted to evaluate a State-led intervention for performance-based financing of health services in two districts of Burkina Faso. In 2015, we analysed data of 1,783 non-indigents and 829 people defined as indigents by their community in 21 villages following community-based targeting processes. Using a classification tree, we built a model to select socioeconomic and health characteristics that were likely to distinguish between non-indigents and indigents. We described the screening performance of the tree using data from specific nodes.

Results

Widow(er)s under 45 years of age, unmarried people aged 45 years and over, and married women aged 60 years and over were more likely to be identified as indigents by their community. Simple rules based on age, marital status, and gender detected indigents with sensitivity of 75.6% and specificity of 55% among those 45 years and over; among those under 45, sensitivity was 85.5% and specificity 92.2%. For both tests combined, sensitivity was 78% and specificity 81%.

Conclusion

In moving toward universal health coverage, Burkina Faso should extend free access to priority health care services to widow(er)s under 45, unmarried people aged 45 years and over, and married women aged 60 years and over, and services should be adapted to their health needs.

Ethics considerations

The collection, storage, and release of data for research purposes were authorized by a government ethics committee in Burkina Faso (Decision No. 2013-7-066). Respondent consent was obtained verbally.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To our knowledge, this is the first published study that identified those who constitute an indigent population in a sub-Saharan African country;
- The results of the study provided local authorities in Burkina Faso with useful information on populations that need urgent health care coverage;
- This study was limited to certain rural areas in Burkina Faso; further research is needed to assess whether these results can be generalized;
- Due to lack of data, we could not perform comparative analyses of the characteristics of people with and without missing data in the study.

INTRODUCTION

Universal health coverage (UHC) has been a key objective for the international community since the call made by the United Nations in 2012. However, given resource constraints, countries must determine their own priorities, and UHC does not mean governments will be able to provide access to all possible health services. High-priority health services should, however, be available to everyone.[1] UHC implementation could follow the path of progressive universalism, which involves initially targeting indigents to support them proportionally to their level of disadvantage and offer them high-priority services.[2] Targeting social benefits in developing countries has proven challenging.[3, 4] More specifically, identifying indigents is a challenge for health care sector reform, particularly in Africa,[5, 6] where two processes have been regularly investigated: community-based targeting (CBT) and proxy mean testing (PMT).[7, 8] Unlike PMT, there are few studies on CBT in sub-Saharan Africa. In Burkina Faso, CBT consists of a process by which the worst-off are selected by a gender-balanced village selection committee of community members appointed by the village health committee. To avoid any capture of local elite,[9-11] the selection committees members cannot be administrative officers, village chiefs, or health committee members. Village selection committees produce lists of indigents whom they select based on a consensual definition and with no pre-determined criteria: ''Someone who is extremely disadvantaged socially and economically, unable to look after him/herself, and devoid of internal or external resources''. The process and the definition were introduced and validated by Ridde et al. in 2007.[12-14]. However, they also showed that user fees exemptions are not enough and that more is needed to ensure indigents benefit from services. [15] Moreover, no study has identified who are those in a state of indigence. Are elderly adults protected informally by their extended families, or do they lack adequate resources to spend on health care in the absence of formal government safety nets and old age pensions? What access do poor women have to health care in societies where men have the decisional power in the family? In a patriarchal society, is being a woman a driver toward indigence?

In this study, our aim was to identify what makes someone an indigent beyond being recognized by his or her community as needing a card for free health care.

POPULATION AND METHODS

Setting

A State-led intervention combining performance-based financing for health care with user fees exemptions for indigents was implemented in 10 districts in Burkina Faso in 2014. It provided increased financing to health care structures and staff based on quantity and quality of care provided. Higher fee-for-service rates were offered for some services delivered to indigents.[16] To identify indigents in each district, a CBT process was implemented in villages concerned by the intervention. In each village, the selection committee was given the entire responsibility and autonomy to select the worst-off within their community. These committees each developed a list of indigents based on their perception of the definition suggested by Ridde et al.[12] These lists were validated by an external committee. The World Bank financed this State-led program, paying up to 7.2 times more for some consultations for indigents than for those of non-indigents.

The study was conducted in 21 villages in two rural districts of Burkina Faso with an agricultural economy: Diébougou (127,857 inhabitants) in the southwest and Gourcy (208,740 inhabitants) in the north. With only four general practitioners and no specialists in both districts, health services use in these areas is very low. In 2014, the average annual number of health visits per inhabitant was 1.03 in Diébougou and 0.73 in Gourcy.[17] These districts are different in terms of agricultural practices, weather conditions, and ethnic composition. They therefore represent a diversity of rural contexts in Burkina Faso. Table 1 presents the villages' total populations in 2011 as well as the numbers of non-indigents and indigents included in the present study.

Study sample

Data were collected between February and April 2015, dry season months when households are more available for interviews than during the agricultural season.

About ten villages were randomly selected in each district (table 1); all households that included an indigent identified by the CBT were included. For comparison, we randomly selected 85% of households without indigence in Diébougou and 45% in Gourcy.

Altogether, 2,077 non-indigents and 1,009 indigents were identified for the study in the two districts.

Data were collected on tablets by trained investigators using Open Data Kit (ODK) software. The household questionnaire included modules on household composition, education, assets, and other dimensions. In households including at least one indigent, an individual health questionnaire survey was administered to the indigent member(s). In households without an indigent, an individual member was randomly selected and administered the same individual health questionnaire.

Study variables

Individual-level variables were selected based on health determinants reported in previous studies in Africa:[18-21]

- Demographic characteristics: gender (male, female), age (18–24, 25–34, 35–44, 45–59, 60+), marital status (single, monogamous union or living together, polygamous union, divorced or separated, widowed);

- Socio-economic characteristics: highest level of education (none, primary school, secondary school); engaging in income-producing activity in the past seven days; difficulties satisfying food needs; financial constraints making it difficult to buy food, use the health care centre, or buy medicines;

- Health: self-rated health (poor, not poor); self-reported chronic disease; visual impairment;

- Physical functioning: physical disability; limitations in walking 400 metres; upper limb strength limitations.

Ethics

An ethics committee of the Government of Burkina Faso approved the study (Decision No. 2013-7-066). Respondent consent was obtained verbally.

Data sharing

No additional data were available.

Statistical methods

Chi-squared tests were used to compare socio-economic characteristics, health status, and physical functioning of non-indigents and indigents.

To create classification models (IBM SPSS Statistics Version 22), we used the IBM SPSS Decision Trees procedure. Classification and regression tree analysis is a non-parametric exploratory method that partitions the sample using explanatory variables so that segments obtained are as homogenous as possible with regard to the dependent variable.[22] Using the Quick Unbiased Efficient Statistical Tree method (QUEST), we built a model that allowed us to select socio-economic, health status, and physical functioning characteristics that were most likely to split non-indigents from indigents. All variables available for this study were specified in the decision tree model. Fourteen were included in the final model procedure: gender, age, highest level of education, marital status, engaging in income-producing activity, financial difficulties (financial constraints making it difficult to buy food or use the health care centre), perceived poor health, chronic disease, visual impairment, disability, ability to walk, and physical strength. Variables that did not contribute significantly were automatically removed from the final model.

The target category was "indigent". For each split, the association between each covariable and the target category was computed using Pearson's chi–square. At each step, the covariable showing the highest association with the target category was selected for splitting.[22] When specifying the model, we set an equal cost of misclassification for non-indigents and indigents, the value of alpha for splitting nodes at 0.05, minimum parent node size at 50, and parent node size at 25. We also performed a sensitivity analysis setting a higher cost of misclassification for indigents (twice that for non-indigents). We randomly split the sample into two subsamples (both including non-indigents and indigents), and the models were fitted using the first as a training sample

and then testing on the second subsample. Trees were generated to maximum size, where each node contained single-class data or no test offered improvement on the mix of classes at that node, then pruned to avoid over-fitting. We also assessed the screening performance of the test tree using CBT as a base-case standard for classification of indigents and non-indigents, since this was the approach adopted by the authorities in Burkina Faso to identify indigents for access to services.

RESULTS

We identified 2,077 non-indigents and 1,009 indigents for the study in the two districts. A total of 1,783 (85.8%) non-indigents and 829 (82.2%) indigents aged 18 years and over with complete questionnaires were considered in the present analysis. A total of 294 non-indigents' questionnaires were incomplete and could not be used for the analyses. Indeed, during the period of the interview, 59 indigents were absent from their house, 13 were sick, 22 were too old to respond to the questionnaire, 49 were disabled, 30 did not complete their interview, and 8 indigents had died. Unfortunately, we did not have details on the missing questionnaires for the non-indigents.

Characteristics of the study population

Of the total sample population, 1,433 (54.9%) lived in Gourcy, 1,555 (59.5%) were women, and 574 (22.0%) were aged 60 years and over. Most were illiterate (2,312, 88.5%); more than one-third (1,004, 38.4%) had difficulties satisfying food needs; 9.4% (246) had difficulties walking 400 metres, and 15.5% (406) perceived their health as poor.

Table 2 presents the study sample characteristics by indigent status. Indigents were more likely to be women, older, illiterate and/or widowed. They were also more likely to be in poor health and to find it financially difficult to cover basic needs.

Classification of non-indigents and indigents

Figure 1 presents the test tree diagram. Age, marital status, gender, upper limb strength limitations, and financial constraints preventing healthcare centre use and purchase of foodstuffs were the best covariates for separating non-indigents from indigents. All p-values for splitting the nodes were below 0.0001.

We used colour codes to represent tree nodes according to proportions of indigents: red (nodes 3, 9, and 15, with proportions of indigents above 75%); orange (nodes 1, 5, 8, 11, 18, 19, proportions between 50% and 75%); yellow (proportions between 25% and 50%), and green for groups with proportions under 25%. Red nodes (3, 9, and 15) could be used as screening tests with high specificity. Since the first partitioning variable, aged

45 years and over, was so strongly associated with indigence, we developed separate screening schemes for those aged 45 years and over and those under 45.

Screening performance of the classification tree

Among those aged 45 and over, two nodes (3 and 15) had high prevalence of indigence. Node 3, which comprised those 45 years and over who were unmarried, contained 150 of the total 332 indigents (45%) in that age group. The sensitivity of "being unmarried" to detect indigence among those 45 years and over was 45% (150/332), and specificity was 83% (218/264). Node 15, married women aged 60 years and over, had a prevalence of indigence of 81.6% and could be used to screen for indigence among those 45 years and over who were married, with sensitivity of 34% (62/182) and specificity of 94% (204/218). By combining nodes 3 and 15, we obtained a test of indigence among those 45 years and over with sensitivity of 64% and specificity of 77%.

Among those under 45, there was only one red node: node 9, being widowed. The sensitivity of "being widowed" for indigence was 66% (55/83), and specificity was 99.2% (610/615). Combining these two screening criteria for those 45 years and over and those under 45, we obtained sensitivity of 64.3% and specificity of 92.6%.

Indigence was largely restricted to being old and unmarried. Indeed, the frequency of indigence among young people (<45 years) who were married or living with a partner was only 4.3% (Table 3).

Goodness of fit of the classification tree was evaluated by the index value and the gains and index charts. The index value of the model was above 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. Risk of misclassification was 14.8%. Overall percentage of correct classification was 85.2%. The sensitivity analysis presented in Appendix 1 (figure 2) confirmed that age, gender, and marital status were strongly correlated with indigence.

DISCUSSION

Using survey data on individuals in 21 villages of two rural districts in Burkina Faso, we used classification and regression tree methodology to identify the best indicators of indigence, as defined by the community. Results showed that being aged 45 years and over, unmarried, and/or a woman were strong indicators of being an indigent, according to the community-based definition. Using simple rules based only on easy-to-obtain indicators of age, marital status, and gender, we were able to detect three-quarters of indigents among those aged 45 years and over and six out of seven indigents among those under 45.

Population aging has emerged as a major demographic trend even in low-income countries like Burkina Faso, posing challenges to social institutions.[23] With a population estimated at 17.59 million in 2014 and a poverty headcount ratio of 46.7%, Burkina Faso is one of the poorest countries in the world. Life expectancy has increased in recent years, estimated at 58 years for males and 59 for females in 2013.[24] To our knowledge, in middle- and low-income countries like Burkina Faso, despite increases in the older adult population generating a greater burden of chronic conditions,[25] social and health policies to adapt to the changing age structure are rare. McEniry and McDermott [26] describe low-income countries like Burkina Faso as countries where mortality declined rapidly very late in the 20th century. However, in these countries, the health of older cohorts is shaped by survivorship of poor early-life conditions, resulting in early onset of chronic diseases and high prevalence of frailty. Our study showed that aging leads to both poor health and deprivation in Burkina Faso. Roth,[27] studying intergenerational relations in Burkina Faso, reported that strength, energy, and therefore the opportunity to earn one's keep decreased with age. Those who cannot participate in reciprocal exchanges of gifts or services risk social marginalization. Yet with no social security[19, 28] and without exchange relations, there is no social recognition.

Our study also revealed that unmarried people were more likely to be indigents. As marriage in Africa marks the transition to adulthood, single persons are not recognized as adults able to assume responsibilities.[27] Marriage confers status and dignity,[29] providing individuals with a sense of meaning and of obligation to others, while

inhibiting risky behaviours and encouraging healthy ones.[30] Previous studies have reported that single, divorced, or bereaved persons showed higher mortality and morbidity in specific diseases,[31-33] as well as lower quality of life[34] compared with those who were married or cohabiting. The differences between married and unmarried people may reflect not only a causal effect of marriage but also a selection effect: healthier people may be more likely than others to find mates and marry.[35]

Widows across the globe share two common experiences: loss of social status and reduced economic circumstances.[36] In developed countries, widowhood is experienced primarily by elderly women, while in developing countries it also affects younger women, many of whom are still rearing children. Widowers, even when elderly, are far more likely to remarry,[37] but this is not the case for widows, who, if they do remarry, rarely do so of their own free will. As a result, many women spend a long period of their lives in widowhood, with all its associated disadvantages and stigmas.[36] In a recent study, Lloyd-Sherlock et al. found that the association between widowhood and being in the poorest household wealth quintile was consistent across most countries (China, Ghana, India, the Russian Federation, and South Africa).[37] In Burkina Faso, the sociocultural context is still marked by beliefs and practices leading to discrimination against women, particularly older women, including widow inheritance, forced marriage, and social exclusion of women for witchcraft allegations. Belief in witchcraft is more dominant in rural areas, where poverty usually leads to strained human and in-law relations, and where most illnesses cannot be explained.[38] Women victims of such violence and discrimination are mostly seniors, have had no children or only girls, have emigrated, or their children have not "succeeded". They are widowed or postmenopausal, poor, and uneducated.[39] In our study, women who were indigents were likely to carry health consequences of their reproductive history. After surviving adolescent childbirth and multiparity, they were at high risk of lower physical performance,[40] chronic diseases, incontinence [41], or fistula.[42] Supporting this line of evidence, Doulougou et al.[33] reported that widows in Burkina Faso were more vulnerable to hypertension than were married women of similar age, education, and health behaviours.

The classification tree showed that even married women, if aged 60 years and over, were more likely to be indigents. Power inequalities in gender relationships, affecting access to resources and decision-making on sexual and reproductive issues, are frequent in West African societies.[43] Harmful cultural practices, such as widow cleansing, son preference, and others, remain threats to women's health and well-being.[44] Onadja et al.[45] reported that being a woman was positively associated with higher odds of cognitive impairment and mobility disability in Burkina Faso, and the size of associations appeared insensitive to adjustment for various life-course socioeconomic and health conditions. Females make up an increasing proportion of the world's poor.[46] This situation is exacerbated by age and marital status, as shown in this research.

In the present study, we considered CBT as a base-case standard for the classification of indigents and non-indigents. According to Conning and Kenave[47], CBT may lead to increased conflict and division within the community and places high time costs on community leaders. Program goals may be subverted to serve elite interests, or local targeting preferences might differ substantially from national or donor preferences. However, the social acceptability, validity, and effectiveness of the CBT process have been documented in Burkina Faso.[48-50] Schleicher et al.[11], who compared decentralized versus statistical targeting of anti-poverty programs, found that in the sub-Saharan African context community-based targeting is far more cost-effective than any statistical targeting procedure for welfare program benefits.

Potential limitations of this study include the fact that the results may not be representative of all of Burkina Faso because the study targeted only certain rural areas. Moreover, self-reported health included in this study may say more about people's health awareness, health expectations, and overall life satisfaction than about their actual health, especially in a poor population with little engagement with services.

Policy implications

The way the State is organized often exacerbates existing social cleavages, intensifying inequalities between rich and poor. For many vulnerable groups, such as older adults, unmarried adults, and widowed women, changes over the past decade have eroded important social safety networks and practices. Targeting the poorest for free access to health care or financial assistance has emerged as an alternative to UHC in many low-

and middle-income countries. Such targeting requires effective selection strategies. Our results showed that, as identified by the community, the indigent population in some rural areas in Burkina Faso is comprised of three groups: widow(er)s under 45, unmarried people aged 45 years and over, and married women aged 60 years and over. Using the country's 2014 Demographic Health Survey data, we selected and described these groups and found they represented 1% of the total population under age 45, 23% of those aged 45 and over, and 45% of people aged 60 and over. Given scarce resources in Burkina Faso, a budget impact analysis is needed to estimate the financial consequences of extending access to free health care services to other sub-groups of populations. The government's ability and willingness to support and sustain these programs must be assessed. These analyses should also explore the trade-offs between sensitivity and specificity in the classification of indigents and non-indigents and investigate the consequences of including these groups.

In moving toward UHC, the government of Burkina Faso has implemented, since April 2, 2016, free access to maternal and child health care. However, as reported here, there are other vulnerable groups with poor health and limited access to health services. Health care in Burkina Faso should include high-priority services to unmarried people under 45 and those aged 45 years and over (as in Senegal, where elderly people have free access to health care),[51] particularly widow(er)s and older women, and services should be adapted to their health needs, including chronic diseases. Extending free access to health care services to these vulnerable populations living in rural areas may be a pertinent public health intervention.

Conclusion

Using an original study method, this research sheds light on indigence by presenting the characteristics of indigents as perceived by their own communities. Indigence is rare among the married population under 45 and frequent among unmarried adults and older adults, particularly widows(er)s and older women. Indigent people reported poorer health, chronic disease, and limitations in physical functioning. This implies that patient-centred health care for indigent people must take into account age and gender, as well as the management of chronic conditions.

AUTHORS' CONTRIBUTIONS

Samiratou Ouédraogo performed the statistical analysis, interpreted the results, reviewed the literature, and prepared the manuscript.

Valéry Ridde was involved in conception of the study design, data collection, statistical analysis, interpretation of results, literature review, and manuscript preparation.

Nicole Atchessi, Aurélia Souares, Jean-Louis Koulidiati, and Quentin Stoeffler participated in conception of the study design, data collection, and manuscript preparation.

Maria-Victoria Zunzunegui was involved in conception of the study design, statistical analysis, interpretation of results, literature review, and manuscript preparation.

All authors read and approved the final manuscript.

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COMPETING INTERESTS

The authors declare that they have no conflicts of interest.

TABLES

Table 1: Total population in each village and number of non-indigents and indigents

Villages	Total population in 2011	Non-indigents	Indigents
District of Gourcy (North region)			
Bassi	3140	272	18
Palle	1602	100	12
Garou	627	26	38
Doure	1297	69	36
Kibilo	2799	180	19
Leleguere	765	50	27
Minima	1413	82	24
Zankolga	546	35	32
Ranoua	2190	124	27
Bouloulou	2131	115	32
Rassomde	1940	99	16
District of Diébougou (South-west region)			
Obro	641	47	38
Sorindigui	534	55	38
Bonfesso	633	94	28
Nabere	864	120	35
Tansie	1412	88	166
Olbontoune	312	27	71
Diagnon	264	9	30
Diourao	556	32	53
Tiakoura	216	31	37

Poyo	950	128	27

Table 2: Comparison of socio-economic characteristics and health status between non-indigents and indigents

Variables	Total Number	Non-indigents		Indigents		P value
		Number	Percentage	Number	Percentage	
		1783		**829**		
District						<0.0001
Diébougou	1179	631	35.4	548	66.1	
Gourcy	1433	1152	64.6	281	33.9	
Gender						<0.0001
Male	1057	802	45.0	255	30.8	
Female	1555	981	55.0	574	69.2	
Age (years)						<0.0001
18–24	368	364	20.4	4	0.5	
25–34	555	524	29.4	31	3.7	
35–44	457	328	18.4	129	15.6	
45–59	658	333	18.4	325	39.2	
60+	574	234	13.1	340	41.0	
Highest level of education achieved						<0.0001
None	2312	1522	85.4	790	95.3	
Primary school	213	188	10.5	25	3.0	
Secondary school	87	73	4.1	14	1.7	
Marital status						<0.0001
Single	111	68	3.8	43	5.2	
Monogamous union or living together	1308	1035	58.0	273	32.9	
Polygamous union	715	562	31.5	153	18.5	
Divorced or separated	25	8	0.4	17	2.1	
Widowed	453	110	6.2	343	41.4	

Engaged in income-producing activity in the past 7 days						<0.0001
No	2044	1344	75.4	700	84.4	
Yes	568	439	24.6	129	15.6	
Difficulties satisfying food needs						<0.0001
No	1608	1219	68.4	389	46.9	
Yes	1004	564	31.6	440	53.1	
Financial difficulties that prevent buying foodstuffs						<0.0001
No	1561	1210	67.9	351	42.3	
Yes	1051	573	32.1	478	57.7	
Financial difficulties that prevent going to the health care centre						<0.0001
No	1553	1250	70.1	303	36.6	
Yes	1059	533	29.9	526	63.4	
Financial difficulties that prevent buying medicines						<0.0001
No	1610	1280	71.8	330	39.8	
Yes	1002	503	28.2	499	60.2	
Perceived poor health						<0.0001
No	2206	1629	91.4	577	69.6	
Yes	406	154	8.6	252	30.4	
Chronic disease						<0.0001
No	1592	1243	69.7	349	42.1	
Yes	1020	540	30.3	480	57.9	
Disability						<0.0001
No	2297	1679	94.2	618	74.5	
Yes	315	104	5.8	211	25.5	
Perceived limitations in ability to walk 400m						<0.0001
No	2366	1702	95.5	664	80.1	
Yes	246	81	4.5	165	19.9	
Perceived limitations in upper limb strength						<0.0001
No	2282	1697	95.2	585	70.6	

Yes	330	86	4.8	244	29.4	
Visual impairment						0.4
No	2560	1745	97.9	815	98.3	
Yes	52	38	2.1	14	1.7	

Table 3: Screening performance of the test tree

Characteristics	Test tree nodes	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Under 45	Red node (9)	0.66 (55/83)	0.99 (610/615)	0.92 (55/60)	0.96 (610/638)
45 years+	Red nodes (3, 15)	0.64 (212/332)	0.77 (204/264)	0.78 (212/272)	0.63 (204/324)
All ages	Red nodes (3, 9, 15)	0.64 (267/415)	0.93 (814/879)	0.80 (267/332)	0.85 (814/962)

Data are percentages, with numbers of patients in parentheses:

- Sensitivity in under 45 was 66% (red node) = (Total indigents in node 9) / (Total indigents in this age group; node 2) x 100.

- Specificity in all ages was 93% (red nodes) = [(Total non-indigents in node 1) – (Total non-indigents in nodes 3)] + [(Total non-indigents in node 2) – (Total non-indigents in nodes 5)] / Total non-indigents in all ages groups (nodes 1 and 2) x 100.

- Positive predictive value in all ages was 80% (red nodes 3, 9, and 15) = (Total indigents in red nodes 3, 9, and 15) / (Total non-indigent and indigents in red nodes 3, 9, and 15) x 100.

- Negative predictive value in under 45 was 98% (red and orange nodes) = [(Total non-indigents in node 2) – (Total non-indigents in nodes 5 and 11)] / [(Total indigents in node 2 – Total indigents in nodes 5 and 11) + (Total non-indigents in node 2 – Total non-indigents in nodes 5 and 11)] x 100.

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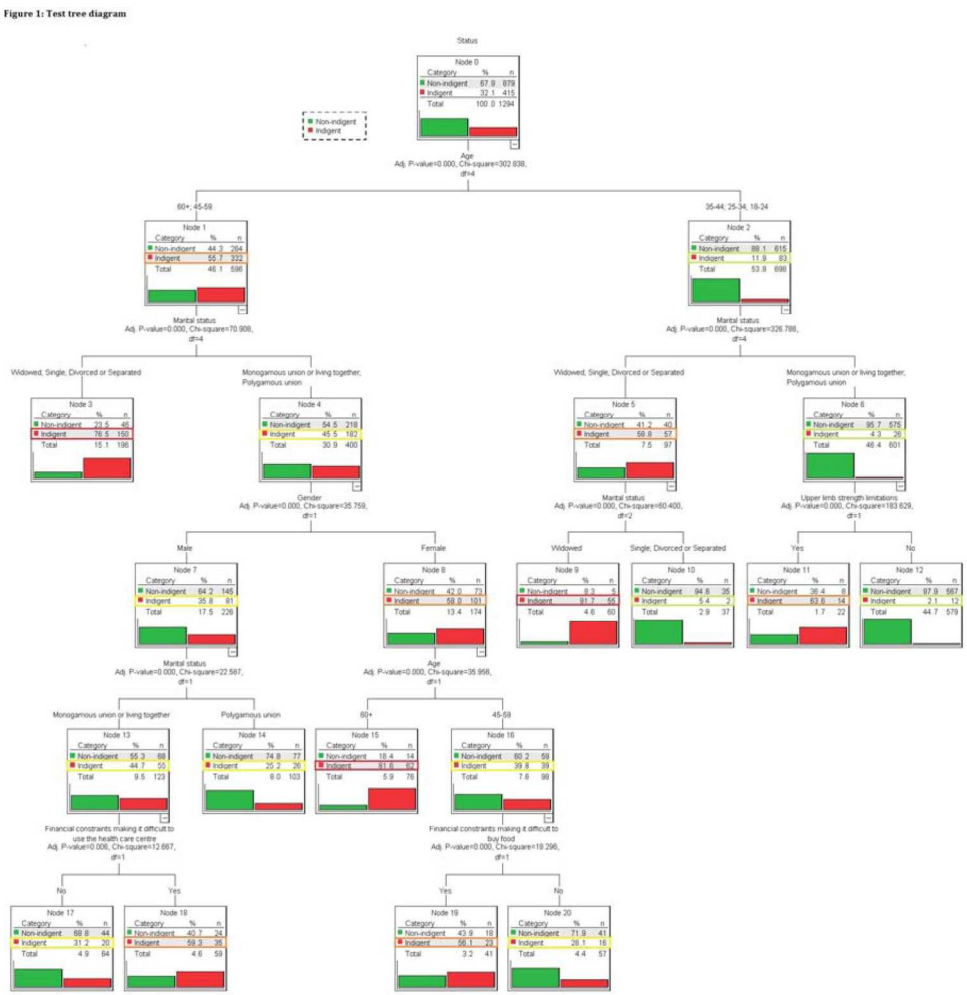


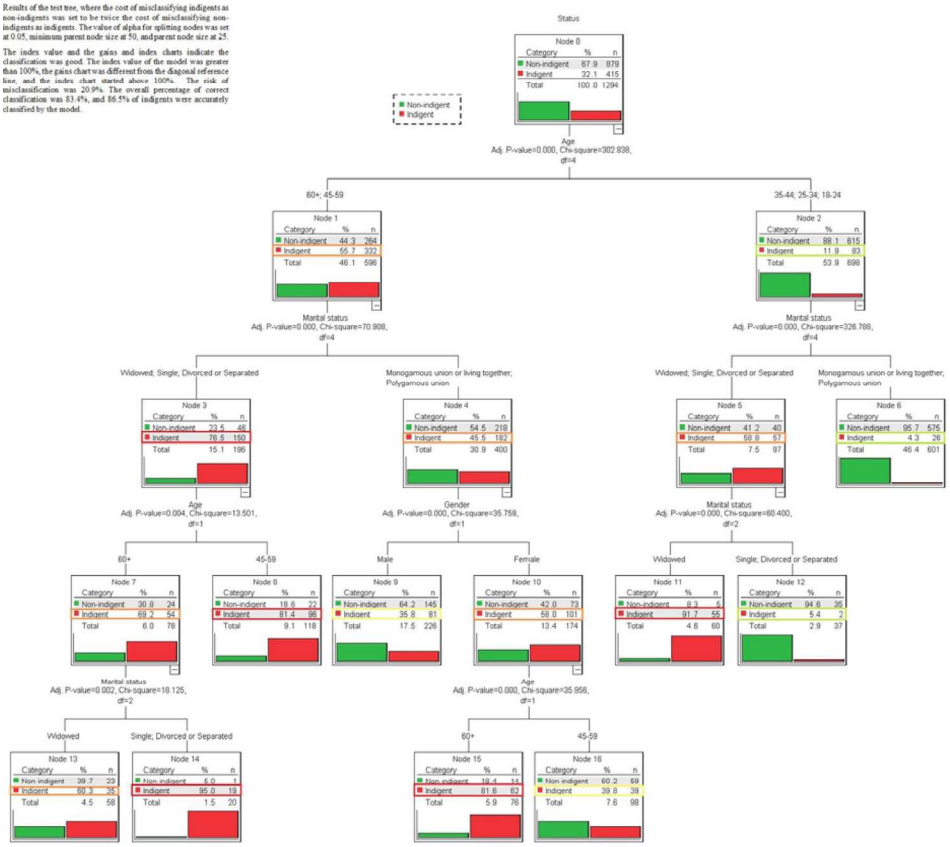
Test tree diagram

159x162mm (300 x 300 DPI)

APPENDIX 1: sensitivity analysis

Results of the test tree, where the cost of misclassifying indigents as non-indigents was set to be twice the cost of misclassifying non-indigents as indigents. The value of alpha for splitting nodes was set at 0.05, minimum parent node size at 50, and parent node size at 25.

The index value and the gains and index charts indicate the classification was good. The index value of the model was greater than 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. The risk of misclassification was 20.9%. The overall percentage of correct classification was 83.4%, and 86.5% of indigents were accurately classified by the model.



Sensitivity analysis of the tree diagram

159x143mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8-9
		(*e*) Describe any sensitivity analyses	11 & Appendix
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on	10

		exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	22
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	14

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

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Characterization of the rural indigent population in Burkina Faso: a screening tool for setting priority health care services in sub-Saharan Africa

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RESEARCH ARTICLE

Title: **Characterization of the rural indigent population in Burkina Faso: a screening tool for setting priority health care services in sub-Saharan Africa.**

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ABSTRACT

Background

In Africa, health research on indigent people has focused on how to target them for services, but little research has been conducted to identify the social groups that compose indigence. Our aim was to identify what makes someone indigent beyond being recognized by the community as needing a card for free health care.

Methods

We used data from a survey conducted to evaluate a State-led intervention for performance-based financing of health services in two districts of Burkina Faso. In 2015, we analysed data of 1,783 non-indigents and 829 people defined as indigents by their community in 21 villages following community-based targeting processes. Using a classification tree, we built a model to select socioeconomic and health characteristics that were likely to distinguish between non-indigents and indigents. We described the screening performance of the tree using data from specific nodes.

Results

Widow(er)s under 45 years of age, unmarried people aged 45 years and over, and married women aged 60 years and over were more likely to be identified as indigents by their community. Simple rules based on age, marital status, and gender detected indigents with sensitivity of 75.6% and specificity of 55% among those 45 years and over; among those under 45, sensitivity was 85.5% and specificity 92.2%. For both tests combined, sensitivity was 78% and specificity 81%.

Conclusion

In moving toward universal health coverage, Burkina Faso should extend free access to priority health care services to widow(er)s under 45, unmarried people aged 45 years and over, and married women aged 60 years and over, and services should be adapted to their health needs.

Ethics considerations

The collection, storage, and release of data for research purposes were authorized by a government ethics committee in Burkina Faso (Decision No. 2013-7-066). Respondent consent was obtained verbally.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- To our knowledge, this is the first published study that identified those who constitute an indigent population in a sub-Saharan African country;
- The results of the study provided local authorities in Burkina Faso with useful information on populations that need urgent health care coverage;
- This study was limited to certain rural areas in Burkina Faso; further research is needed to assess whether these results can be generalized;
- Due to lack of data, we could not perform comparative analyses of the characteristics of people with and without missing data in the study.

INTRODUCTION

Universal health coverage (UHC) has been a key objective for the international community since the call made by the United Nations in 2012. However, given resource constraints, countries must determine their own priorities, and UHC does not mean governments will be able to provide access to all possible health services. High-priority health services should, however, be available to everyone.[1] UHC implementation could follow the path of progressive universalism, which involves initially targeting indigents to support them proportionally to their level of disadvantage and offer them high-priority services.[2] Targeting social benefits in developing countries has proven challenging.[3, 4] More specifically, identifying indigents is a challenge for health care sector reform, particularly in Africa,[5, 6] where two processes have been regularly investigated: community-based targeting (CBT) and proxy mean testing (PMT).[7, 8] Unlike PMT, there are few studies on CBT in sub-Saharan Africa. In Burkina Faso, CBT consists of a process by which the worst-off are selected by a gender-balanced village selection committee of community members appointed by the village health committee. To avoid any capture of local elite,[9-11] the selection committees' members cannot be administrative officers, village chiefs, or health committee members. Village selection committees produce lists of indigents whom they select based on a consensual definition and with no pre-determined criteria: ''Someone who is extremely disadvantaged socially and economically, unable to look after him/herself, and devoid of internal or external resources''. The process and the definition were introduced and validated by Ridde et al. in 2007.[12-14] However, they also showed that user fees exemptions are not enough and that more is needed to ensure indigents benefit from services. [15] Moreover, no study has identified who are those in a state of indigence. Are elderly adults protected informally by their extended families, or do they lack adequate resources to spend on health care in the absence of formal government safety nets and old age pensions? What access do poor women have to health care in societies where men have the decisional power in the family? In a patriarchal society, is being a woman a driver toward indigence?

In this study, our aim was to identify what makes someone an indigent beyond being recognized by his or her community as needing a card for free health care.

POPULATION AND METHODS

Setting

A State-led intervention combining performance-based financing for health care with user fees exemptions for indigents was implemented in 10 districts in Burkina Faso in 2014. It provided increased financing to health care structures and staff based on quantity and quality of care provided. Higher fee-for-service rates were offered for some services delivered to indigents.[16] To identify indigents in each district, a CBT process was implemented in villages concerned by the intervention. In each village, the selection committee was given the entire responsibility and autonomy to select the worst-off within their community. These committees each developed a list of indigents based on their perception of the definition suggested by Ridde et al.[12] These lists were validated by an external committee. The World Bank financed this State-led program, paying up to 7.2 times more for some consultations for indigents than for those of non-indigents.

The study was conducted in 21 villages in two rural districts of Burkina Faso with an agricultural economy: Diébougou (127,857 inhabitants) in the southwest and Gourcy (208,740 inhabitants) in the north. With only four general practitioners and no specialists in both districts, health services use in these areas is very low. In 2014, the average annual number of health visits per inhabitant was 1.03 in Diébougou and 0.73 in Gourcy.[17] These districts are different in terms of agricultural practices, weather conditions, and ethnic composition. They therefore represent a diversity of rural contexts in Burkina Faso. Table 1 presents the villages' total populations in 2011 as well as the numbers of non-indigents and indigents included in the present study.

Study sample

Data were collected between February and April 2015, dry season months when households are more available for interviews than during the agricultural season.

About ten villages were randomly selected in each district (table 1); all households that included an indigent identified by the CBT were included. For comparison, we randomly selected 85% of households without indigence in Diébougou and 45% in Gourcy.

Altogether, 2,077 non-indigents and 1,009 indigents were identified for the study in the two districts.

Data were collected on tablets by trained investigators using Open Data Kit (ODK) software. The household questionnaire included modules on household composition, education, assets and other dimensions. In households including at least one indigent, an individual health questionnaire survey was administered to the indigent member(s). In households without an indigent, an individual member was randomly selected and administered the same individual health questionnaire.

Study variables

Individual-level variables were selected based on health determinants reported in previous studies in Africa:[18-21]

- Demographic characteristics: gender (male, female), age (18–24, 25–34, 35–44, 45–59, 60+), marital status (single, monogamous union or living together, polygamous union, divorced or separated, widowed);

- Socio-economic characteristics: highest level of education (none, primary school, secondary school); engaging in income-producing activity in the past seven days; difficulties satisfying food needs; financial constraints making it difficult to buy food, use the health care centre, or buy medicines;

- Health: self-rated health (poor, not poor); self-reported chronic disease; visual impairment;

- Physical functioning: physical disability; limitations in walking 400 metres; upper limb strength limitations.

Ethics

An ethics committee of the Government of Burkina Faso approved the study (Decision No. 2013-7-066). Respondent consent was obtained verbally.

Data sharing

No additional data were available.

Statistical methods

Chi-squared tests were used to compare socio-economic characteristics, health status, and physical functioning of non-indigents and indigents.

To create classification models (IBM SPSS Statistics Version 22), we used the IBM SPSS Decision Trees procedure. Classification and regression tree analysis is a non-parametric exploratory method that partitions the sample using explanatory variables so that segments obtained are as homogenous as possible with regard to the dependent variable.[22] Using the Quick Unbiased Efficient Statistical Tree method (QUEST), we built a model that allowed us to select socio-economic, health status, and physical functioning characteristics that were most likely to split non-indigents from indigents. All variables available for this study were specified in the decision tree model. Fourteen were included in the final model procedure: gender, age, highest level of education, marital status, engaging in income-producing activity, financial difficulties (financial constraints making it difficult to buy food or use the health care centre), perceived poor health, chronic disease, visual impairment, disability, ability to walk and physical strength. Variables that did not contribute significantly were automatically removed from the final model.

The target category was "indigent". For each split, the association between each covariable and the target category was computed using Pearson's chi–square. At each step, the covariable showing the highest association with the target category was selected for splitting.[22] When specifying the model, we set an equal cost of misclassification for non-indigents and indigents, the value of alpha for splitting nodes at 0.05, minimum parent node size at 50, and parent node size at 25. We also performed a sensitivity analysis setting a higher cost of misclassification for indigents (twice that for non-indigents). We randomly split the sample into two subsamples (both including non-indigents and indigents), and the models were fitted using the first as a training sample

and then testing on the second subsample. Trees were generated to maximum size, where each node contained single-class data or no test offered improvement on the mix of classes at that node, then pruned to avoid over-fitting. We also assessed the screening performance of the test tree using CBT as a base-case standard for classification of indigents and non-indigents, since this was the approach adopted by the authorities in Burkina Faso to identify indigents for access to services.

RESULTS

We identified 2,077 non-indigents and 1,009 indigents for the study in the two districts. A total of 1,783 (85.8%) non-indigents and 829 (82.2%) indigents aged 18 years and over with complete questionnaires were considered in the present analysis. Indeed, during the period of the interview, 58 indigents were absent from their house, 13 were sick, 22 were too old to respond to the questionnaire, 49 were disabled, 30 did not complete their interview, and 8 indigents had died. A total of 294 non-indigents' questionnaires were incomplete and could not be used for the analyses. Unfortunately, we did not have details on the missing questionnaires for the non-indigents.

Characteristics of the study population

Of the total sample population, 1,433 (54.9%) lived in Gourcy, 1,555 (59.5%) were women, and 574 (22.0%) were aged 60 years and over. Most were illiterate (2,312, 88.5%); more than one-third (1,004, 38.4%) had difficulties satisfying food needs; 9.4% (246) had difficulties walking 400 metres, and 15.5% (406) perceived their health as poor.

Table 2 presents the study sample characteristics by indigent status. Indigents were more likely to be women, older, illiterate and/or widowed. They were also more likely to be in poor health and to find it financially difficult to cover basic needs.

Classification of non-indigents and indigents

Figure 1 presents the test tree diagram. Age, marital status, gender, upper limb strength limitations, and financial constraints preventing healthcare centre use and purchase of foodstuffs were the best covariates for separating non-indigents from indigents. All p-values for splitting the nodes were below 0.0001.

We used colour codes to represent tree nodes according to proportions of indigents: red (nodes 3, 9, and 15, with proportions of indigents above 75%); orange (nodes 1, 5, 8, 11, 18, 19, proportions between 50% and 75%); yellow (proportions between 25% and 50%), and green for groups with proportions under 25%. Red nodes (3, 9, and 15) could be used as screening tests with high specificity. Since the first partitioning variable, aged

45 years and over, was so strongly associated with indigence, we developed separate screening schemes for those aged 45 years and over and those under 45.

Screening performance of the classification tree

Among those aged 45 and over, two nodes (3 and 15) had high prevalence of indigence. Node 3, which comprised those 45 years and over who were unmarried, contained 150 of the total 332 indigents (45%) in that age group. The sensitivity of "being unmarried" to detect indigence among those 45 years and over was 45% (150/332), and specificity was 83% (218/264). Node 15, married women aged 60 years and over, had a prevalence of indigence of 81.6% and could be used to screen for indigence among those 45 years and over who were married, with sensitivity of 34% (62/182) and specificity of 94% (204/218). By combining nodes 3 and 15, we obtained a test of indigence among those 45 years and over with sensitivity of 64% and specificity of 77%.

Among those under 45, there was only one red node: node 9, being widowed. The sensitivity of "being widowed" for indigence was 66% (55/83), and specificity was 99.2% (610/615). Combining these two screening criteria for those 45 years and over and those under 45, we obtained sensitivity of 64.3% and specificity of 92.6%.

Indigence was largely restricted to being old and unmarried. Indeed, the frequency of indigence among young people (<45 years) who were married or living with a partner was only 4.3% (Table 3).

Goodness of fit of the classification tree was evaluated by the index value and the gains and index charts. The index value of the model was above 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. Risk of misclassification was 14.8%. Overall percentage of correct classification was 85.2%. The sensitivity analysis presented in Appendix 1 (figure 2) confirmed that age, gender, and marital status were strongly correlated with indigence.

DISCUSSION

Using survey data on individuals in 21 villages of two rural districts in Burkina Faso, we used classification and regression tree methodology to identify the best indicators of indigence, as defined by the community. Results showed that being aged 45 years and over, unmarried, and/or a woman were strong indicators of being an indigent, according to the community-based definition. Using simple rules based only on easy-to-obtain indicators of age, marital status, and gender, we were able to detect three-quarters of indigents among those aged 45 years and over and six out of seven indigents among those under 45.

Population aging has emerged as a major demographic trend even in low-income countries like Burkina Faso, posing challenges to social institutions.[23] With a population estimated at 17.59 million in 2014 and a poverty headcount ratio of 46.7%, Burkina Faso is one of the poorest countries in the world. Life expectancy has increased in recent years, estimated at 58 years for males and 59 for females in 2013.[24] To our knowledge, in middle- and low-income countries like Burkina Faso, despite increases in the older adult population generating a greater burden of chronic conditions,[25] social and health policies to adapt to the changing age structure are rare. McEniry and McDermott [26] describe low-income countries like Burkina Faso as countries where mortality declined rapidly very late in the 20th century. However, in these countries, the health of older cohorts is shaped by survivorship of poor early-life conditions, resulting in early onset of chronic diseases and high prevalence of frailty. Our study showed that aging leads to both poor health and deprivation in Burkina Faso. Roth,[27] studying intergenerational relations in Burkina Faso, reported that strength, energy, and therefore the opportunity to earn one's keep decreased with age. Those who cannot participate in reciprocal exchanges of gifts or services risk social marginalization. Yet with no social security[19, 28] and without exchange relations, there is no social recognition.

Our study also revealed that unmarried people were more likely to be indigents. As marriage in Africa marks the transition to adulthood, single persons are not recognized as adults able to assume responsibilities.[27] Marriage confers status and dignity,[29] providing individuals with a sense of meaning and of obligation to others, while

inhibiting risky behaviours and encouraging healthy ones.[30] Previous studies have reported that single, divorced, or bereaved persons showed higher mortality and morbidity in specific diseases,[31-33] as well as lower quality of life[34] compared with those who were married or cohabiting. The differences between married and unmarried people may reflect not only a causal effect of marriage but also a selection effect: healthier people may be more likely than others to find mates and marry.[35]

Widows across the globe share two common experiences: loss of social status and reduced economic circumstances.[36] In developed countries, widowhood is experienced primarily by elderly women, while in developing countries it also affects younger women, many of whom are still rearing children. Widowers, even when elderly, are far more likely to remarry,[37] but this is not the case for widows, who, if they do remarry, rarely do so of their own free will. As a result, many women spend a long period of their lives in widowhood, with all its associated disadvantages and stigmas.[36] In a recent study, Lloyd-Sherlock et al. found that the association between widowhood and being in the poorest household wealth quintile was consistent across most countries (China, Ghana, India, the Russian Federation, and South Africa).[37] In Burkina Faso, the sociocultural context is still marked by beliefs and practices leading to discrimination against women, particularly older women, including widow inheritance, forced marriage, and social exclusion of women for witchcraft allegations. Belief in witchcraft is more dominant in rural areas, where poverty usually leads to strained human and in-law relations, and where most illnesses cannot be explained.[38] Women victims of such violence and discrimination are mostly seniors, have had no children or only girls, have emigrated, or their children have not "succeeded". They are widowed or postmenopausal, poor, and uneducated.[39] In our study, women who were indigents were likely to carry health consequences of their reproductive history. After surviving adolescent childbirth and multiparity, they were at high risk of lower physical performance,[40] chronic diseases, incontinence [41], or fistula.[42] Supporting this line of evidence, Doulougou et al.[33] reported that widows in Burkina Faso were more vulnerable to hypertension than were married women of similar age, education, and health behaviours.

The classification tree showed that even married women, if aged 60 years and over, were more likely to be indigents. Power inequalities in gender relationships, affecting access to resources and decision-making on sexual and reproductive issues, are frequent in West African societies.[43] Harmful cultural practices, such as widow cleansing, son preference, and others, remain threats to women's health and well-being.[44] Onadja et al.[45] reported that being a woman was positively associated with higher odds of cognitive impairment and mobility disability in Burkina Faso, and the size of associations appeared insensitive to adjustment for various life-course socioeconomic and health conditions. Females make up an increasing proportion of the world's poor.[46] This situation is exacerbated by age and marital status, as shown in this research.

In the present study, we considered CBT as a base-case standard for the classification of indigents and non-indigents. According to Conning and Kenave[47], CBT may lead to increased conflict and division within the community and places high time costs on community leaders. Program goals may be subverted to serve elite interests, or local targeting preferences might differ substantially from national or donor preferences. However, the social acceptability, validity, and effectiveness of the CBT process have been documented in Burkina Faso.[48-50] Schleicher et al.[11], who compared decentralized versus statistical targeting of anti-poverty programs, found that in the sub-Saharan African context community-based targeting is far more cost-effective than any statistical targeting procedure for welfare program benefits.

Potential limitations of this study include the fact that the results may not be representative of all of Burkina Faso because the study targeted only certain rural areas. Moreover, self-reported health included in this study may say more about people's health awareness, health expectations, and overall life satisfaction than about their actual health, especially in a poor population with little engagement with services.

Policy implications

The way the State is organized often exacerbates existing social cleavages, intensifying inequalities between rich and poor. For many vulnerable groups, such as older adults, unmarried adults, and widowed women, changes over the past decade have eroded important social safety networks and practices. Targeting the poorest for free access to health care or financial assistance has emerged as an alternative to UHC in many low-

and middle-income countries. Such targeting requires effective selection strategies. Our results showed that, as identified by the community, the indigent population in some rural areas in Burkina Faso is comprised of three groups: widow(er)s under 45, unmarried people aged 45 years and over, and married women aged 60 years and over. Using the country's 2014 Demographic Health Survey data, we selected and described these groups and found they represented 1% of the total population under age 45, 23% of those aged 45 and over, and 45% of people aged 60 and over. Given scarce resources in Burkina Faso, a budget impact analysis is needed to estimate the financial consequences of extending access to free health care services to other sub-groups of populations. The government's ability and willingness to support and sustain these programs must be assessed. These analyses should also explore the trade-offs between sensitivity and specificity in the classification of indigents and non-indigents and investigate the consequences of including these groups.

In moving toward UHC, the government of Burkina Faso has implemented, since April 2, 2016, free access to maternal and child health care. However, as reported here, there are other vulnerable groups with poor health and limited access to health services. Health care in Burkina Faso should include high-priority services to unmarried people under 45 and those aged 45 years and over (as in Senegal, where elderly people have free access to health care),[51] particularly widow(er)s and older women, and services should be adapted to their health needs, including chronic diseases. Extending free access to health care services to these vulnerable populations living in rural areas may be a pertinent public health intervention.

Conclusion

Using an original study method, this research sheds light on indigence by presenting the characteristics of indigents as perceived by their own communities. Indigence is rare among the married population under 45 and frequent among unmarried adults and older adults, particularly widows(er)s and older women. Indigent people reported poorer health, chronic disease, and limitations in physical functioning. This implies that free priority health care services for indigent people must take into account age and gender, as well as the management of chronic conditions.

AUTHORS' CONTRIBUTIONS

Samiratou Ouédraogo performed the statistical analysis, interpreted the results, reviewed the literature, and prepared the manuscript.

Valéry Ridde was involved in conception of the study design, data collection, statistical analysis, interpretation of results, literature review, and manuscript preparation.

Nicole Atchessi, Aurélia Souares, Jean-Louis Koulidiati, and Quentin Stoeffler participated in conception of the study design, data collection, and manuscript preparation.

Maria-Victoria Zunzunegui was involved in conception of the study design, statistical analysis, interpretation of results, literature review, and manuscript preparation.

All authors read and approved the final manuscript.

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COMPETING INTERESTS

The authors declare that they have no conflicts of interest.

TABLES

Table 1: Total population in each village and number of non-indigents and indigents

Villages	Total population in 2011	Non-indigents	Indigents
District of Gourcy (North region)			
Bassi	3140	272	18
Palle	1602	100	12
Garou	627	26	38
Doure	1297	69	36
Kibilo	2799	180	19
Leleguere	765	50	27
Minima	1413	82	24
Zankolga	546	35	32
Ranoua	2190	124	27
Bouloulou	2131	115	32
Rassomde	1940	99	16
District of Diébougou (South-west region)			
Obro	641	47	38
Sorindigui	534	55	38
Bonfesso	633	94	28
Nabere	864	120	35
Tansie	1412	88	166
Olbontoune	312	27	71
Diagnon	264	9	30
Diourao	556	32	53
Tiakoura	216	31	37

Poyo	950	128	27

Table 2: Comparison of socio-economic characteristics and health status between non-indigents and indigents

Variables	Total Number	Non-indigents		Indigents		P value
		Number	Percentage	Number	Percentage	
		1783		**829**		
District						<0.0001
Diébougou	1179	631	35.4	548	66.1	
Gourcy	1433	1152	64.6	281	33.9	
Gender						<0.0001
Male	1057	802	45.0	255	30.8	
Female	1555	981	55.0	574	69.2	
Age (years)						<0.0001
18–24	368	364	20.4	4	0.5	
25–34	555	524	29.4	31	3.7	
35–44	457	328	18.4	129	15.6	
45–59	658	333	18.4	325	39.2	
60+	574	234	13.1	340	41.0	
Highest level of education achieved						<0.0001
None	2312	1522	85.4	790	95.3	
Primary school	213	188	10.5	25	3.0	
Secondary school	87	73	4.1	14	1.7	
Marital status						<0.0001
Single	111	68	3.8	43	5.2	
Monogamous union or living together	1308	1035	58.0	273	32.9	
Polygamous union	715	562	31.5	153	18.5	
Divorced or separated	25	8	0.4	17	2.1	
Widowed	453	110	6.2	343	41.4	

Engaged in income-producing activity in the past 7 days						<0.0001
No	2044	1344	75.4	700	84.4	
Yes	568	439	24.6	129	15.6	
Difficulties satisfying food needs						<0.0001
No	1608	1219	68.4	389	46.9	
Yes	1004	564	31.6	440	53.1	
Financial difficulties that prevent buying foodstuffs						<0.0001
No	1561	1210	67.9	351	42.3	
Yes	1051	573	32.1	478	57.7	
Financial difficulties that prevent going to the health care centre						<0.0001
No	1553	1250	70.1	303	36.6	
Yes	1059	533	29.9	526	63.4	
Financial difficulties that prevent buying medicines						<0.0001
No	1610	1280	71.8	330	39.8	
Yes	1002	503	28.2	499	60.2	
Perceived poor health						<0.0001
No	2206	1629	91.4	577	69.6	
Yes	406	154	8.6	252	30.4	
Chronic disease						<0.0001
No	1592	1243	69.7	349	42.1	
Yes	1020	540	30.3	480	57.9	
Disability						<0.0001
No	2297	1679	94.2	618	74.5	
Yes	315	104	5.8	211	25.5	
Perceived limitations in ability to walk 400m						<0.0001
No	2366	1702	95.5	664	80.1	
Yes	246	81	4.5	165	19.9	
Perceived limitations in upper limb strength						<0.0001
No	2282	1697	95.2	585	70.6	

Yes	330	86	4.8	244	29.4	
Visual impairment						0.4
No	2560	1745	97.9	815	98.3	
Yes	52	38	2.1	14	1.7	

Table 3: Screening performance of the test tree

Characteristics	Test tree nodes	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Under 45	Red node (9)	0.66 (55/83)	0.99 (610/615)	0.92 (55/60)	0.96 (610/638)
45 years+	Red nodes (3, 15)	0.64 (212/332)	0.77 (204/264)	0.78 (212/272)	0.63 (204/324)
All ages	Red nodes (3, 9, 15)	0.64 (267/415)	0.93 (814/879)	0.80 (267/332)	0.85 (814/962)

Data are percentages, with numbers of patients in parentheses:

- Sensitivity in under 45 was 66% (red node) = (Total indigents in node 9) / (Total indigents in this age group; node 2) x 100.

- Specificity in all ages was 93% (red nodes) = [(Total non-indigents in node 1) – (Total non-indigents in nodes 3)] + [(Total non-indigents in node 2) – (Total non-indigents in nodes 5)] / Total non-indigents in all ages groups (nodes 1 and 2) x 100.

- Positive predictive value in all ages was 80% (red nodes 3, 9, and 15) = (Total indigents in red nodes 3, 9, and 15) / (Total non-indigent and indigents in red nodes 3, 9, and 15) x 100.

- Negative predictive value in under 45 was 98% (red and orange nodes) = [(Total non-indigents in node 2) – (Total non-indigents in nodes 5 and 11)] / [(Total indigents in node 2 – Total indigents in nodes 5 and 11) + (Total non-indigents in node 2 – Total non-indigents in nodes 5 and 11)] x 100.

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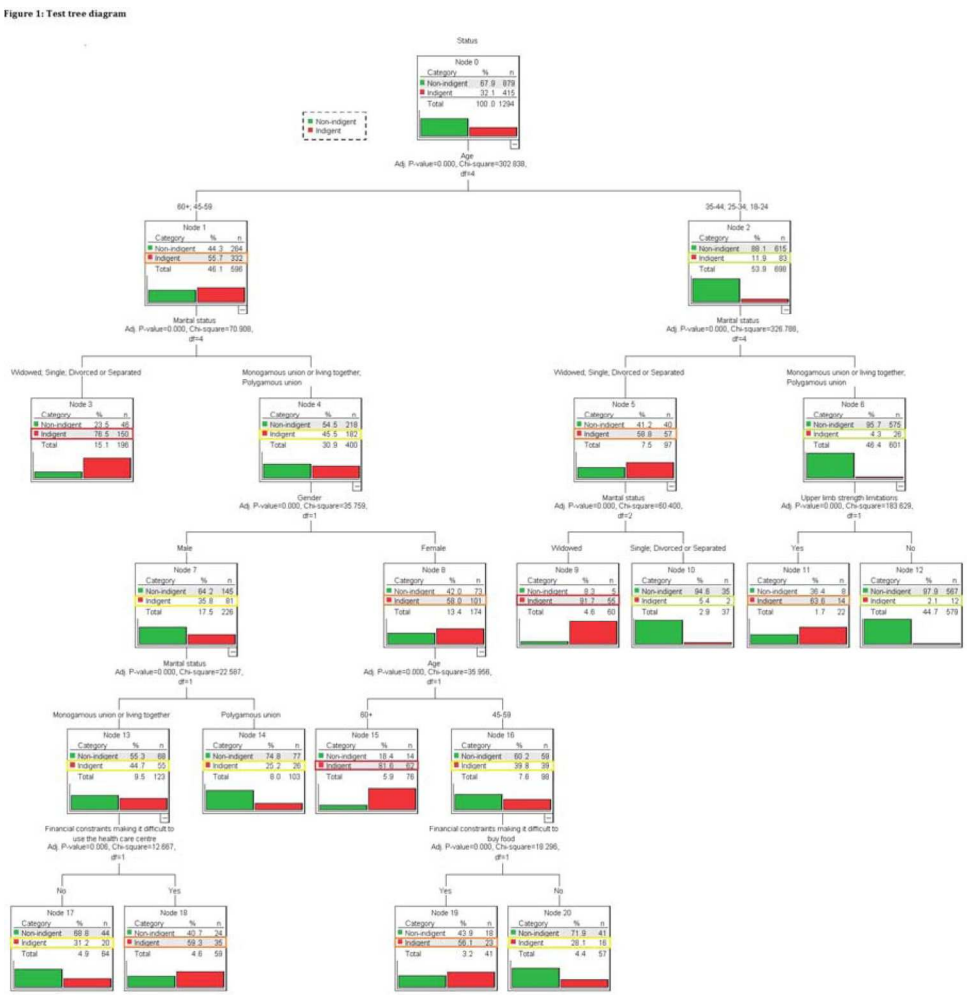


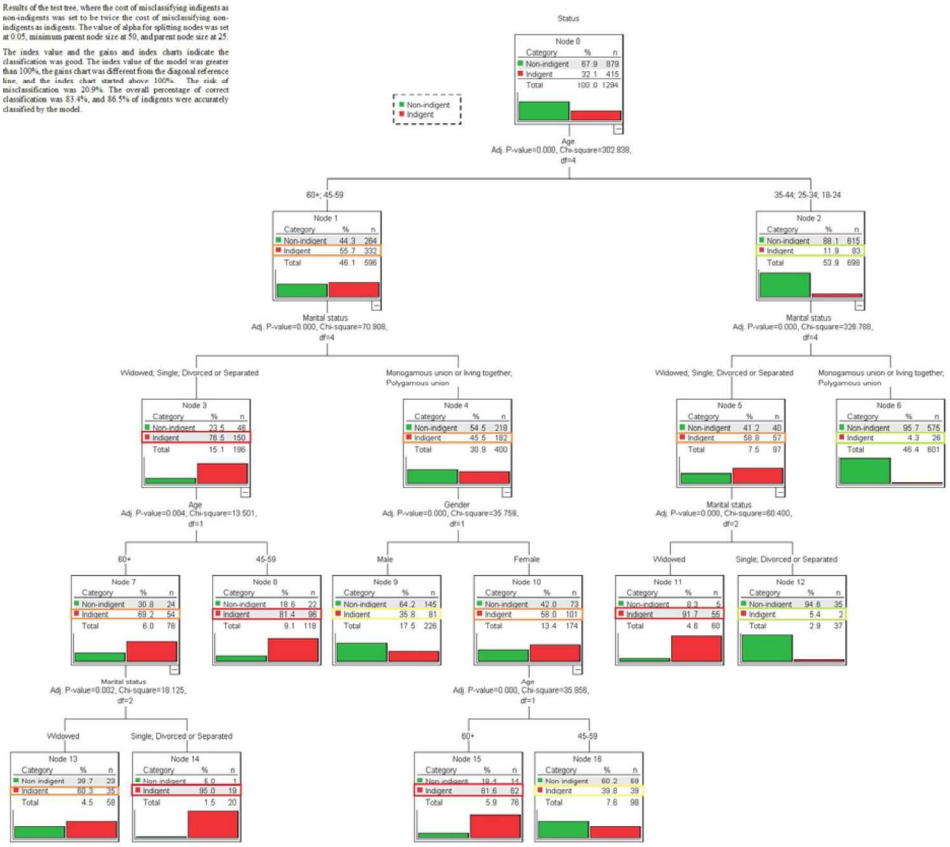
Test tree diagram

159x162mm (300 x 300 DPI)

APPENDIX 1: sensitivity analysis

Results of the test tree, where the cost of misclassifying indigents as non-indigents was set to be twice the cost of misclassifying non-indigents as indigents. The value of alpha for splitting nodes was set at 0.05, minimum parent node size at 50, and parent node size at 25.

The index value and the gains and index charts indicate the classification was good. The index value of the model was greater than 100%, the gains chart was different from the diagonal reference line, and the index chart started above 100%. The risk of misclassification was 20.9%. The overall percentage of correct classification was 83.4%, and 86.5% of indigents were accurately classified by the model.



Sensitivity analysis of the tree diagram

159x143mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8-9
		(*e*) Describe any sensitivity analyses	11 & Appendix
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on	10

		exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	22
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	14

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17