Inequalities and trends in under-five mortality between formal and informal settlements in Ouagadougou, Burkina Faso

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Introduction

With a lower proportion of urban population than other regions of the world, sub-Saharan Africa stands out with a recent, more dynamic, and sustained urbanization process. In 2020, 44% of the inhabitants of this region lived in cities and this proportion is expected to exceed 50% in 2040 according to United Nations projections, due to urban growth estimated at 4% per year (UN, 2018). This urbanization is fuelled primarily by significant natural growth supported by high fertility and lower mortality (Tabutin et al., 2017; Sanchez et al., 2022). It is also accelerated by rural-urban migration of young adults in search of better living conditions. In addition, African cities are rapidly expanding by spreading from the centre to the periphery (Bocquier et al., 2023). These are usually villages located on the outskirts that are engulfed over time by urban growth pushing the boundaries of the city.

This sustained growth of the urban population in SSA in a context of low economic development is at the origin of the emergence of informal neighbourhoods, inhabited by poor populations in search of lower-cost housing (Oai et al., 2007; Bocquier et al., 2010; Cobbinah et al., 2015). These neighbourhoods, also called “slums”, “irregular neighbourhoods” and “undeveloped areas”, are characterized above all by a lack of access to basic social services such as drinking water, sanitation, and a very limited sanitary supply. Although the

configuration of these neighbourhoods and living conditions vary from city to city, it is established that, compared to the inhabitants of formal neighbourhoods, the populations living there have poor health indicators. Various research studies have highlighted this especially regarding children whose health status remains highly dependent on the health environment and the use of care. For example, in Ouagadougou, studies have highlighted a higher risk of mortality for children under five years of age in informal neighbourhoods compared to formal neighbourhoods. This health disadvantage is observed and persists in the neonatal, infant, and juvenile period (Lankoandé et al., 2016; Compaoré et al., 2020). Moreover, the work carried out in Kenya also confirms this excess mortality of children in informal settlements not only compared to other urban residents but also compared to certain rural areas (Kimani-Murage et al., 2014; Gruebner et al., 2015). Beyond mortality, the health disadvantage of informal settlements is clearly visible when looking at other dimensions of child health than malnutrition, diarrhoea, and respiratory infections (Fink et al., 2014; Pörtner et al., 2018).

With a view to improving living conditions in informal settlements, several initiatives have emerged under the auspices of international organizations such as the World Bank and UN Habitat. They range from the simple eviction of the populations of these neighbourhoods to policies of servicing and restructuring in collaboration with local authorities and non-governmental organizations (NGOs) (Baron et al., 2021). However, in recent years, most projects agree on the strategy of restructuring informal settlements in line with goal 11 of the Sustainable Development Goals (SDGs) on access for all to decent housing and basic social services. This essentially consists of land security via legal recognition by the competent authority of the property held by residents to prevent eviction. This allows them to secure and invest more in their habitat. At the same time, the provision of basic social services such as drinking water, sanitation and the construction of adequate roads and sanitary infrastructure makes it possible to better integrate these neighbourhoods into the city. Examples include slum upgrading projects in Ghana, Kenya, Zimbabwe and Burkina Faso (Muchadenyika et al., 2015; Danso-Wiredu et al., 2017; Baron et al., 2021).

As expected, results of these informal settlement strategies, we could expect a reduction in the health disadvantage of informal settlements compared to formal settlements or a convergence of the health status of populations living in both habitat environments. This convergence hypothesis finds its theoretical foundations in the analysis of health inequalities proposed by Vallin et al. (2010). According to this theory, the implementation of adequate public policies can lead to a convergence of health states between elite and non-elite populations over time.

The objective of this article is to analyse trends and inequalities in infant and child mortality between formal and informal neighbourhoods in Ouagadougou, the capital of Burkina Faso. More specifically, it will be necessary to (I) trace the inequalities in mortality of all causes and by group of causes according to the habitat environment (ii) analyse the effects of different urban planning and health policies on the differential of infant and child mortality between formal and informal neighbourhoods.

Context

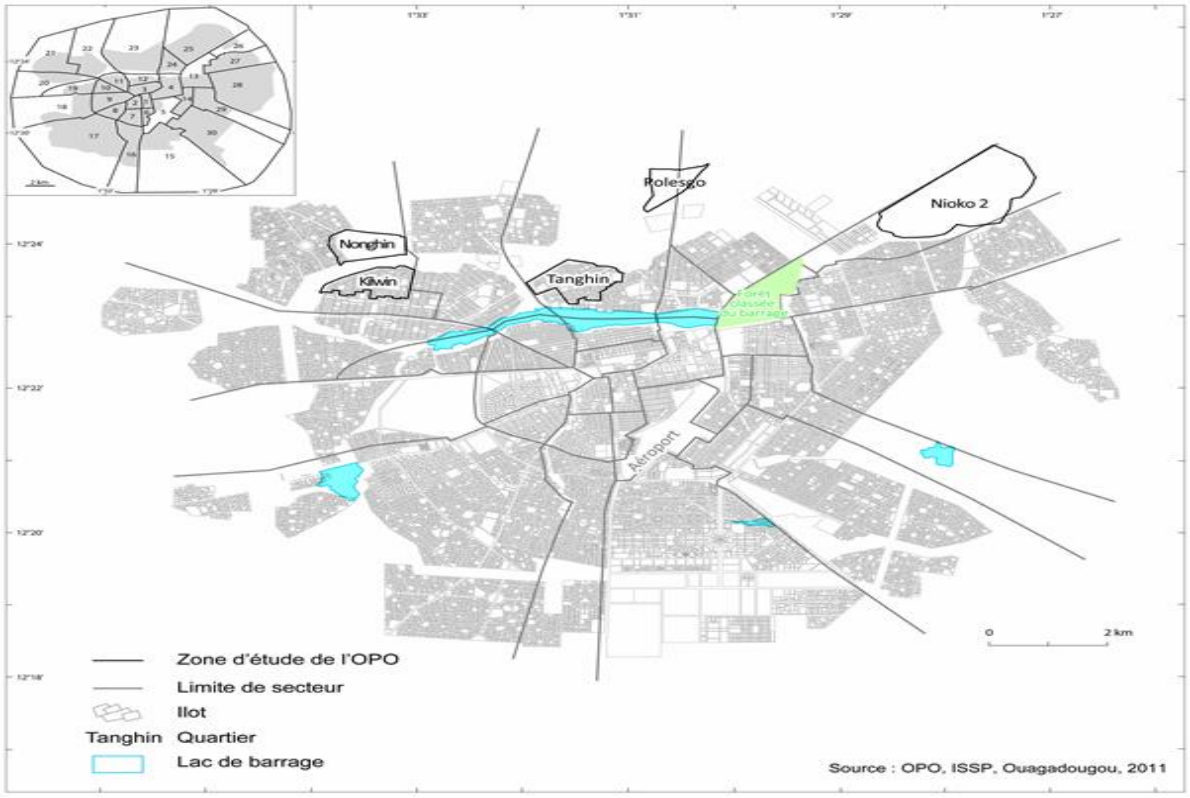
Like the other capitals of Africa south of the Sahara, the population of Ouagadougou, the capital of Burkina Faso, has grown considerably in recent decades. More specifically, it increased 5-fold between 1960 and 2020 to reach 2,5 million inhabitants representing 45,1% of the country's urban population (INSD, 2020). The size of the city increased from 6000 ha in 1960 to 30250 ha in 2014 (Séré, 2020).

The urban development of Ouagadougou dates from the colonization with a certain dichotomy between the developed spaces occupied by Europeans and the informal neighbourhoods welcoming the "indigenous" population. The housing policies of these informal settlements have evolved over time, sometimes under the aegis of international organizations. In 1987 there was a return to the right to private property and to the control of the customary chiefdom over land, particularly in villages on the outskirts of towns (Lefebvre, 2020). This situation will fuel over the years a series of land speculation where villages located on the periphery are erected in unallotted areas pending formal allotment operations. These lofty lands, which acquire market value, are subsequently sold and other informal settlements are created, thus pushing the boundaries of the city. This mode of subdivision has led to various malpractices and conflicts to the extent that the subdivisions were suspended in 2015 in the two main cities of the country, namely Ouagadougou and Bobo-Dioulasso.

Data and methods

Data

The data used come from the Ouagadougou Population Observatory (OPO), one of two urban observatories in sub-Saharan Africa (Sankoh et Byass 2012 ; Ekström et al., 2016). Established in 2008, the OPO follows 5 districts located on the northern outskirts of the city of Ouagadougou, capital of Burkina Faso (Map 1). These 5 neighbourhoods are divided into 2 formal neighbourhoods (Kilwin, Tangin) and 3 informal neighbourhoods (Polesgo, Nioko II, Nongin) (Rossier et al., 2012) with a population under surveillance estimated at 36 920 and 57 491 inhabitants respectively in 2018.



Map 1: Areas under demographic surveillance

OPO data are collected on the entire population of the areas covered and updated through regular passages with a periodicity of 10 months. They contain information on vital events (births, migrations, deaths, etc.), demographic and socio-economic characteristics (level of education, marital status, religion, ethnicity, migration, death, occupation status, household assets, etc.). In the event of death, probable causes of death are collected through the verbal autopsy method and analysed using Inter-VA software (Byass et al., 2012). The derived causes of death are then classified according to the International Classification of Diseases (ICD) version 10 (who,2012).

The data considered in this analysis cover the period 2010 – 2018 and cover 896 deaths among children under 5 years of age. The contribution of this age group in terms of person-years over the period considered is 57356.79. Among these deaths, probable causes of death were deducted for 71% of cases. These figures are estimated at 67% and 73% respectively in formal and informal neighbourhoods. Refusals, removals, the absence of the ideal respondent and the lack of information on some AV cards to determine the cause of death, explain this loss of deaths in terms of certification of the cause of death. For the purposes of this analysis, causes of death

were grouped into 7 groups, namely malaria, respiratory diseases, neonatal causes (congenital malformation, prematurity, birth asphyxia, neonatal pneumonia, neonatal sepsis and other unspecified COD), diarrhoea, malnutrition and other causes of death (non-obstetric sepsis, HIV, meningitis and encephalitis, measles).

Statistical analyses

We conducted an analysis of all-cause mortality trends by cause by habitat environment based on the calculation of annual mortality rates for children under 5 years of age. These rates were obtained by dividing the number of deaths by the number of person-years at risk. Data from the last years ((2019-2021)) of collection are not available for analysis purposes.

In a second step, we smoothed trends in child mortality in each type of zone to eliminate random fluctuations and highlight inequalities in mortality over time. This smoothing was done using Poisson modelling from a person-periods file (Schumacher, 2004). The variable to be explained is the number of deaths and time the main explanatory variable. This has been decomposed using a "cubic spline interpolation" (Smith, 2004).

As for the analysis of mortality by cause group, the rates were calculated by period according to the type of neighbourhood to overcome staffing problems. The analysis period (2010-2018) was divided into three sub-periods: 2010-2012, 2013-2015 and 2016-2018. The first period corresponds to the beginning of demographic surveillance excluding the base year (2009) and the last period coincides with the implementation of the policy of free care and the cessation of subdivision operations. We have taken care to redistribute the unknown causes of death proportionally among those known.

To test the hypothesis of mortality convergence between formal and informal neighbourhoods over the period, we used a Poisson regression model using the period, neighbourhood type and interaction between these two variables as the main explanatory variables. The objective was to assess the evolution of the health disadvantage of informal settlements over time. The control variables include the child's sex, the characteristics of the mother (educational level, age group, ethnic group, religion, marital status) and the characteristics of the household (access to drinking water, type of Toilet and household size).

Results

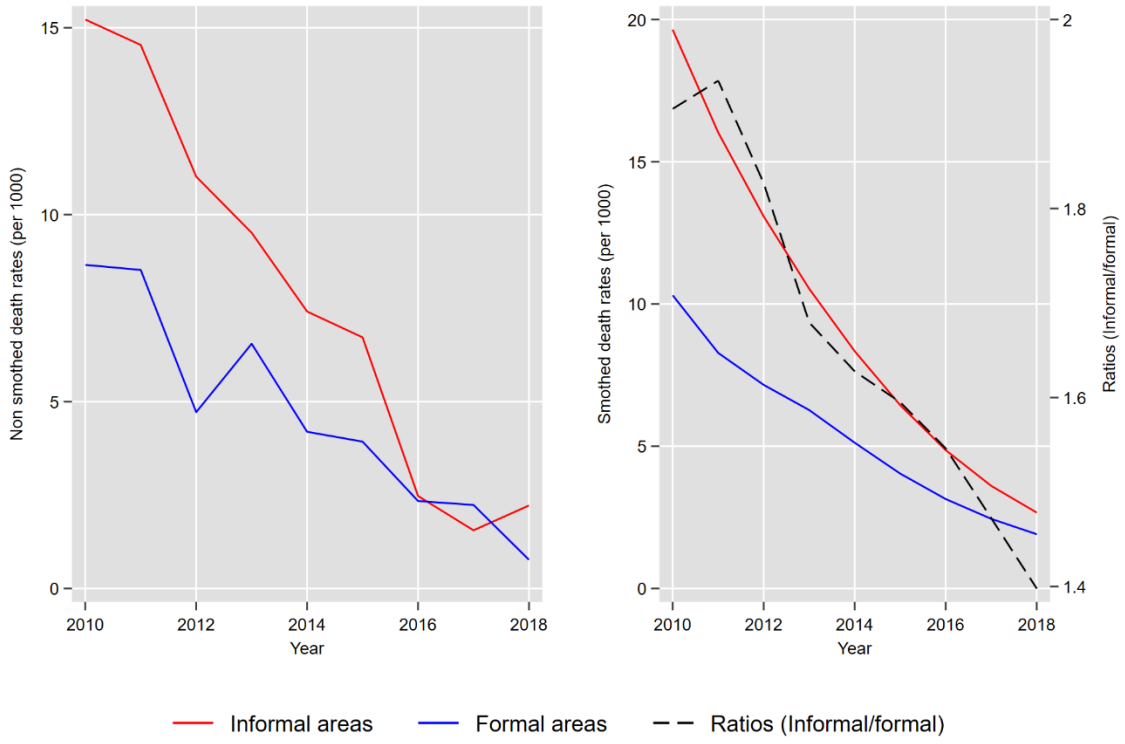
The Figure 1 retraces the trends in infant and child mortality according to the habitat environment in the OPO over the period 2010-2018. The first graph shows the non-smoothed mortality rates as deduced from the data, while the second graph shows the smoothed rates. In addition to the graph, Table 1 quantifies the absolute and relative differences in mortality levels between formal and informal neighbourhoods by period.

Table 1. Under five mortality rates (per 1000)) by period and type of settlement (2010-2018)

Period	Formal	Informal	Absolute difference	Relative difference
2010-2012	12.8 [10.6 – 15.5]	24.4 [21.9 – 27.3]	11.7	91.1%
2013-2015	11.3 [9.0 – 14.2]	19.1 [16.8 – 21.7]	7.8	68.6%
2016-2018	6.3 [4.5 – 8.8]	10.7 [9.0 – 12.8]	4.5	71.0%
Total	**10.6** [9.3 – 12.1]	**18.4** [17.1 – 19.9]	**7.8**	**74.1%**

Over the entire period 2010-2018, changes in mortality levels show that children from undeveloped areas are at a higher risk of death than children living in undeveloped areas. However, Figure 1 suggests a reduction in the gaps in infant and child mortality between “loti” and “non-loti” neighbourhoods over the years, although non-loti areas remain disadvantaged in 2018. This reduction in mortality inequalities between the two habitats stems from a faster decline in infant and child mortality in informal neighbourhoods compared to formal neighbourhoods. Indeed, the level of the mortality ratio between informal and formal settlements rose from 1,9 in 2010 to almost 1,4 in 2018. In the same dynamic, the absolute difference in mortality levels was estimated at 11.7 per 1000 at the beginning of the period and fell to 4.5 per 1000 at the end of the period. As for the relative difference, it decreased overall over the period 2013-2018 compared to the period 2010-2012, going from 91% to almost 70%.

Figure 1 : Trends in infant and child mortality by type of zone 2010-2018



In more detail, we also analysed mortality trends by cause or group of causes in both habitat settings (Figure 2). Malaria, respiratory infections, diarrhoea, and neonatal causes are the main causes of death regardless of the neighbourhood and observation period. The observed decline in all-cause mortality seems to be mainly related to the decline observed in these main causes of death. In formal neighbourhoods, there is a relatively smaller decline in mortality associated with malaria and diarrhoea, compared with larger declines in deaths related to respiratory infections and neonatal causes. On the other hand, informal settlements recorded a more pronounced decline in malaria mortality and respiratory infection mortality, especially at the end of the period. However, the level of mortality due to neonatal causes remained stable during the period, while mortality due to diarrhoea evolved rather sawtooth in these types of neighbourhoods.

Fig. 2: Trends in cause specific mortality by type of settlement, 2010 – 2018

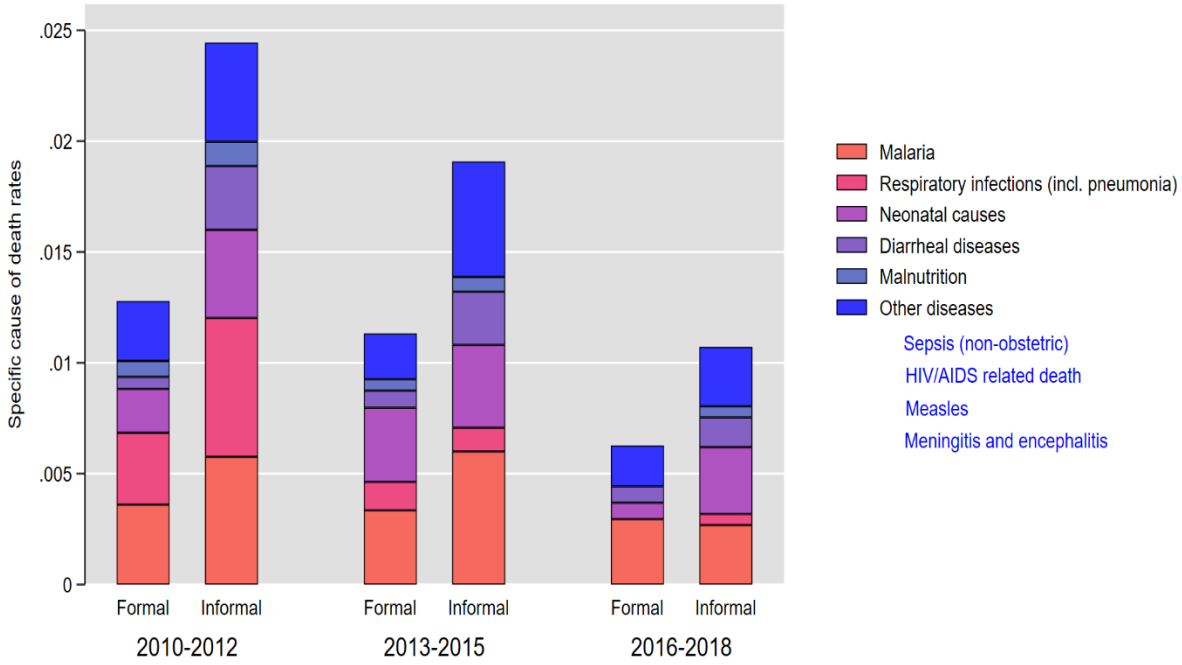


Table 2 presents the relative incidence of infant and child mortality by area type, period, interaction between area type and period, and other control variables obtained from the Poisson model. First, it appears that mortality decreased over the entire analysis period with a significant decrease over the period 2016-2018. However, the decline in mortality between the period 2010-2012 and the period 2013-2015 is not significant. As expected, children living in formal neighbourhoods enjoy a health advantage compared to those in informal neighbourhoods. This mortality inequality remains after considering control variables such as the sex of the child, household size, water source, type of toilet used, level of education, age group, ethnicity, religion, and marital status of the mother. All things being equal, the risk of death is 73% higher in informal neighbourhoods compared to formal neighbourhoods over the analysis period. However, this net disadvantage of informal settlements has not been constant over time. It declined over time with a clear and statistically significant difference between the periods 2016-2018 and 2010-2012.

The analysis also revealed that factors such as the age of the mother and the source of water used are also associated with child mortality, although these results are only significant at the 10% threshold. In terms of maternal age, compared to children of young mothers (under 35 years of age), children with older mothers are at higher risk of mortality. Compared to the

fountain terminal and other water sources, the availability of a tap in the household is more beneficial for children in terms of health.

Table 2: Relative incidence of infant and child mortality in OPO, 2010-2018

Variables	IRR (Raw effects)	P-Val	95% CI	IRR (net effects)	P-Val	95% CI
Zone type						
parcelled out	1			1		
non-parcelled out	1.8	0.000	1:37 AM– 2:38 AM	1.73	0.001	1:26 AM – 2:38 AM
Periods						
2010 – 2012	1			1		
2013 - 2015	0.7	0.124	0.498-1.088	0.75	0.155	0.50– 1:12 AM
2016 - 2018	0.3	0.000	0.148 – 0.489	0.28	0.000	0.15– 0.51
Area type x periods						
non-parcelled out 2010 – 2012	1			1		
non-parcelled out 2013 - 2015	0.8	0.256	0.500– 1.203	0.78	0.276	0.50 – 1:21 AM
non-parcelled out 2016 - 2018	0.5	0.067	0.265 – 1.047	0.52	0.067	0.26 – 1:05 AM
Gender						
Male				1		
Female				1:12 AM	0.185	0.95 – 1:33 AM
Level of education of the mother						
None				1		
Primary				1:02 AM	0.888	0.82– 1:26 AM
Secondary and above				0.83	0.212	0.62– 1:11 AM
Missing value				0.91	0.615	0.63– 1:31 AM
Age group of the mother						
Under 35 years of age				1		
35 years and over				1:28 AM	0.063	0.99 – 1.67
Ethnicity of the mother						
Mossi				1		
Others				1:13 AM	0.388	0.85 – 1:45 AM
Religion of the mother						
Catholics				1		
Not Catholic				0.92	0.344	0.76 – 1:10 AM
Marital status of the mother						
Married				1		
Unmarried				0.79	0.378	0.46 – 1:34 AM
Household water source						
Other sources (wells, hand pumps, street vendors, rainwater)				1		
Public fountain terminal				0.95	0.627	0.76 – 1:18 AM
Valve				0.72	0.076	0.50 – 1:04 AM
Type of Toilet in the household						
No Toilet				1		
Simple latrines				0.74	0.185	0.47– 1:16 AM

Other (flushing and ventilated latrine)				1:16 AM	0.584	0.68 – 1.96
Household size						
Less than 5 people				1		
5 people and more				1:13 AM	0.206	0.94 – 1:36 AM

216

217

Discussion

This research focused on the dynamics of inequalities in infant and child mortality between formal and informal neighbourhoods in Ouagadougou, the capital of Burkina Faso. The analysis is based on longitudinal data collected by the Ouagadougou Population Observatory over a recent period: 2010-2018. Compared to previous research on the subject, this analysis relates the dynamics of mortality inequalities between the two habitat environments with contextual factors and various health and urban development policies in the city of Ouagadougou. Moreover, the use of data on mortality by causes, rarely available in the general population, has made it possible to support the results on the dynamics of mortality inequalities.

The results of the analysis confirm the excess mortality of children in informal neighbourhoods compared to those in formal neighbourhoods as documented elsewhere in the literature (Fink et al., 2014; Lankoandé et al., 2016). This vulnerability of children living in remote areas is mainly due to socio-demographic, economic and behavioural parameters (Djourdebbé et al., 2015; Soura et al., 2015; Rossier et al., 2016). However, mortality differentials have narrowed over time with a faster decline in mortality in undeveloped areas. The main source of this reduction is a sharp decline in deaths from malaria and respiratory infections in informal settlements. Overall, these results give credit to a hypothesis of a rapid improvement in living conditions coupled with a better use of care in these informal neighbourhoods.

The improvement of living conditions in undeveloped neighbourhoods may be associated with the closure of housing estates and projects for the servicing and restructuring of informal neighbourhoods, while the increase in the use of care is explained by the policy of free care for pregnant women and children under five, adopted by the Burkinabe government from March 2016.

Indeed, various projects to improve informal settlements have been implemented in recent years in the city of Ouagadougou, with a view to improving the living conditions of the populations living there. By way of illustration, the project for the development and opening up of peripheral districts (PADQP), whose activities began in the period 2007-2011, aimed to facilitate access to basic social services for populations in irregular neighbourhoods (Baron et al., 2021). More specifically, a partnership between private operators and the National Office of Water and Sanitation (ONEA) has made it possible to test a drinking water supply system in the homes of residents of these neighbourhoods. Two OPO areas benefited from this project (Nonghin and Polesgho). In the same vein, the project “Sustainable sanitation in the undeveloped and

peripheral districts of the commune of Ouagadougou in Burkina Faso" (PERISAN) made it possible to carry out 15 913 family works (latrines) for the benefit of 80 406 people in 30 undeveloped districts, including those monitored by the OPO (Sow, 2019). The city has also benefited from the Ouagadougou Peripheral District Sanitation Project (SPAQPO), which aimed to improve rainwater drainage systems, collect and recover solid waste and open up peripheral districts. Most recently, the Ministry of Urban Planning and Housing in collaboration with international partners launched a project to restructure "not well off" neighbourhoods in several regions of the country, including Ouagadougou. It is essentially an in-situ restructuring that consists of developing roads in informal neighbourhoods and establishing basic social infrastructure. The pilot phase of this project is currently being implemented in a rural municipality (Saaba) in the Central Region. This non-exhaustive list of the various servicing projects carried out in informal neighbourhoods is likely to improve the health conditions of the populations living there and consequently contribute to accelerating the decline in mortality in these neighbourhoods.

Secondly, it should be remembered that the quest for residential autonomy is one of the reasons that pushes people to settle in informal neighbourhoods in the city of Ouagadougou. The populations live there hoping that the State will undertake subdivision operations that would allow them to be the formal owners of the occupied lands. These usually gain value in the event of a subdivision. This strategy led them gradually to invest in their housing which is usually demolished during the operations of formal allocation of plots. However, this land occupation approach has been severely tested in recent years when the state has stopped subdivision operations in the city of Ouagadougou since 2015. This measure may encourage people to invest more in their living environment, and this may have a positive impact on their health and consequently on the mortality of children living in the area. This is the case, for example, of the Polesgho district where communities sometimes organized in association, with the support of some partners such as NGOs, are striving to improve their living environment through the installation of fountains and the construction of social infrastructure such as health centres and schools (Baron et al., 2021).

Finally, it should be mentioned that some public policies are likely to benefit the poorest more than the wealthy. Recent work by Samandoulgou and colleagues ((2022)) shows that the policy of free health care implemented since March 2016 has reduced inequalities in access to care between the poor and the rich in Burkina Faso. Similar results have been documented in Sierra Leone (Bognini et al., 2021). In addition, some initiatives specifically target indigent

populations. This is the case for social safety nets (cash transfers or not) and certain projects such as the solidarity approach project in reproductive health (PASSAGE). This project, implemented between 2006 and 2009, aimed to improve the offer of services, access and quality of care for certain target populations: young adolescents, pregnant women and their families and the most deprived population identified with NGOs and local associations (Dubourg et al., 2010).

It is imperative to mention the few limitations of this research. Initially, the Ouagadougou Population Observatory is not representative of the city of Ouagadougou as a whole. However, beyond this question of representativeness, the longitudinal nature of the data makes it possible to highlight causal mechanisms that would not be different for the rest of the city. Secondly, it was difficult for us to establish in a statistical approach a causal relationship between policies, projects and the dynamics of mortality inequalities between formal and informal neighbourhoods over the period of analysis.

Beyond these few limits, this article revives the debates on health inequalities according to the socio-economic gradient in cities of developing countries in general. On the one hand, the health disadvantage of the poor persists in most African capitals and seems to contribute precisely to the erosion of the urban advantage in terms of health compared to the rural world (Amouzou et al., 2023). Of the other part, the example of cities such as Ouagadougou suggests a rapid decline in mortality in the city due to a convergence of mortality levels between spontaneous habitats and formal neighbourhoods adequate policies for the benefit of the poorest could accelerate the transition of mortality in cities in countries in the Netherlands development pathway and thus contribute to the achievement of SDG target 3.2 to reduce preventable deaths among newborns and children under five in general.

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