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Area-Based Policies and Potential Health Benefits: A Quasi-Experimental Cohort Study in Vulnerable Urban Areas of Andalusia (Spain)

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Abstract: Area-based policies (ABIs) aim to improve the quality of life and health of residents in socio-economically disadvantaged areas of cities. Although health impact evaluations of ABIs have proliferated in the last decade, several weaknesses have been identified in these evaluations. Inspired by the propositions of the fundamental cause theory (FCT), this paper attempts to address some of these weaknesses by investigating the possible impacts of different combinations of ABIs on premature mortality in vulnerable urban areas of Andalusia (Spain). We conducted a quasi-experimental cohort study, based on the longitudinal statistics on survival and longevity of a population aged 40–70 during the period from 2002 to 2016. Hazard ratios for individuals living in targeted areas relative to control areas were estimated using quasi-Poisson regressions, and the impact was evaluated using a difference-in-difference approach. Most of the ABIs studied do not seem to generate a visible impact on premature mortality. However, the combination of ARB and URBAN interventions is associated with a significant decrease in preventable and all-cause mortality in the targeted versus control areas. The flexible resources proposed by FCT can operate at both the contextual and individual levels, since more comprehensive interventions seem to contribute to achieving health impacts on vulnerable populations. Future evaluations should consider the nature of the intervened areas themselves in relation to the dynamics of the city and the degree of comprehensiveness of the policies, to elucidate what may constitute "fundamental interventions" to reduce health disparities between urban places.

Keywords: area-based policies; health impact; fundamental cause theory; mortality; health inequalities; vulnerable urban contexts

1. Introduction

The growth of urban populations is one of the challenges for public health, as it increases the risk of health inequalities due to the spread of deprived urban areas. In such areas, urban infrastructures and facilities are insufficient to meet the needs of the resident population [1]. Galea and Vlahov [2] identify three broad categories of theories and mechanisms that can explain how the urban context can affect health. First is the physical or built environment, which includes access to urban infrastructure, water, sanitation, green places, and favorable climate conditions. Second is the social environment, as a concept related to processes of deprivation and/or social disorganization within cities. This involves the mechanism of social contagion, which emphasizes the idea that individuals shape their health-related practices according to the behaviors and attitudes prevailing in their close social networks, and includes processes related to the social segregation of urban space and other social inequalities. Third, and related to the above, is the availability

of and access to resources and services provided by specific institutional interventions or urban policies. Based on this knowledge, urban policies that seek to improve the quality of life of people living in the most deprived urban areas are advocated in order to address contemporary health inequalities. In 2008, the Commission on Social Determinants of Health (WHO) published a report entitled "Closing the gap in a generation—how?" highlighting the need to focus urban management and planning on health equity in order to build healthy environments and achieve higher levels of health equality [3].

In recent decades, an urban policy agenda has emerged that aims to improve the socio-economically disadvantaged areas of cities. It is argued that such investment and revitalization programs in deprived urban areas can contribute, both directly and indirectly, to improving the quality of life and health of residents [4,5]. Influences on health could derive from the implementation of specific actions in the field of preventive policies, health promotion, and/or health education interventions, and from improving access to healthcare services. However, above all, this type of policy assumes that it is improvements in a compendium of resources linked to the urban habitat, housing, and environment that can contribute to mitigating the negative effect of social disadvantage on health. In addition, area-based initiatives (ABIs) often also include interventions aimed at improving community life, such as residents' perceptions and prevailing cultural conceptions, community participation, and the promotion of mutual support networks. Therefore, these interventions on the "community dimension" of neighborhoods could also influence residents' opportunities concerning choice, affecting their health-related lifestyles and different health outcomes [6–9]. Some studies have shown moderate influences of such policies on health [10–12].

In line with Abel and Frohlich's [13] arguments regarding the importance of the capabilities approach in policymaking to reduce health inequalities, we conceive ABIs as institutional interventions that are ideally suited to integrating the principle of structurally transformative agency. Such initiatives assume that sectoral and general welfare policies are not sufficient to solve the multitude of problems in urban areas where poverty and social disadvantage are concentrated. The criticism has been made that a simple area-based approach cannot address many of these broader structural problems [14,15]. However, from the point of view of health inequalities, ABIs can promote changes in the immediate context of individuals that broaden the range of healthy opportunities with which people can effectively engage. This sets the conditions for health-relevant agency, from which improved well-being may in turn result. Along these lines, previous empirical studies have documented that ABIs can prevent, or at least reduce, the widening of social inequalities in health and in some of its most relevant determinants [16–18].

Although health impact evaluations of ABIs have proliferated in the last decade, a number of weaknesses have been identified in these evaluations. The issues can be summarized as follows: (1) a lack of evaluation of designs guided by theories and hypotheses about specific mechanisms; (2) expecting effects that are unlikely to be achieved by interventions in the short term; (3) the use of small samples and shortcomings in the causal attribution of potential effects; (4) the absence of cohort studies with the prospective follow-up of individuals, as these could avoid methodological problems caused by changes in the composition of the populations residing in the targeted areas; and (5) the lack of experimental designs involving comparison groups that would allow for improved causal inferences about effects [10,12,19].

The current research aims to explore the possible impacts of ABIs on the risk of mortality from different groups of causes. Our focus is on the impact assessment of urban rehabilitation areas, a program implemented in vulnerable areas of different cities in Andalusia (Spain) between 1999 and 2012. The evaluative approach is theoretically grounded in the precepts of fundamental cause theory (FCT). In addition, a design that combines cohort data with quasi-experimental methodology is used to address some of the weaknesses identified in the previous literature.

Theory and Hypotheses

The fundamental cause theory (FCT) proposes four basic conditions, suggesting that socio-economic status (SES) is a "root" cause of the persistence of health inequalities, and not just a distant or confounding factor of other individual proximate causes. First, SES influences multiple health outcomes, and second, it influences multiple risk factors. These first two basic propositions suggest that the persistence of health inequality cannot be explained by looking exclusively at contingent associations between specific health outcomes and their corresponding risk factors. Third, SES implies access to flexible resources (money, knowledge, power, prestige, and beneficial social connections) that can be used to help avoid diseases or minimize their consequences. Due to differential access to these resources, individuals develop increased or reduced capabilities to adopt strategies that protect and improve their own health. Lastly, the FCT points to a fourth basic condition, which states that the association between SES and health will be reproduced over time through the replacement of mediating mechanisms [20–22]. Thus, it is postulated that social inequality in health is reproduced as we gain preventive control over disease and mortality. In other words, the reproduction of health inequalities has its origin in the unequal returns on the advances in preventive knowledge at each historical moment, especially in those contexts that favor the unequal distribution of so-called "flexible resources" [23].

In recent years, there has been a proliferation of studies attempting to test the core assumptions of this theory. These studies often test the role of flexible resources linked to SES by comparing their influence on health outcomes where greater advantages are likely to be gained by those with a higher SES (for example, diseases for which advanced preventive knowledge is available) with other health outcomes where—due to a lack of advances in preventive knowledge—flexible resources are unlikely to have a protective effect [24–30]. However, despite the strength of the empirical findings concerning the basic precepts of FCT, it is striking that it has not been used more extensively to theoretically guide evaluations of institutional interventions that aim to reduce health inequalities, particularly in the case of comprehensive and/or intensive policies that aim to achieve transformations in the immediate social context of people's daily life, influencing the structure of opportunities, and consequently the distribution of flexible resources in society and/or the capabilities of individuals to use them for the benefit of their own health [17]. Following the logic of a pre-assessment that incorporates the precepts of the FCT, ABIs implemented in vulnerable urban areas could contribute to mitigating or moderating the health inequities of the resident population. However, such a moderating effect would only be possible in the case of outcomes or diseases for which preventive knowledge has been widely developed. Accordingly, the following hypotheses emerge for our evaluative proposal:

Hypothesis (H1). ABIs moderate the mortality risk of residents in vulnerable urban areas when the combination of interventions is more holistic.

Hypothesis (H2). The influence of ABIs on mortality risks only exists for preventable mortality, where "flexible resources" may contribute to such influence (when the disease or its consequences can be avoided).

Hypothesis (H3). There is no relationship between ABIs and mortality for which less preventive knowledge is available.

2. Materials and Methods

2.1. Area Based Interventions Analyzed

The focus of this research is on analyzing the program for urban rehabilitation areas (termed ARB), developed within the framework of the housing policy of the Andalusian Autonomous Community, in urban spaces where habitability problems are concentrated (housing, buildings, and surroundings). The ARB program was implemented intensively from 1999 to 2012 by the Department of Public Works and Housing of the Regional Govern-

ment of Andalusia. The aim was to improve habitability through actions targeting housing and the environment: housing and building regeneration, eradication of substandard housing and public space urbanization, and—more recently—energy efficiency. However, it also includes actions oriented at improving residents' social integration and community life, for example, by the promotion of neighborly relations and public participation. The bulk of ARB investments have gone into the construction of public housing (45%), followed by interventions to eradicate substandard housing (14%), the refurbishment of unique buildings in run-down areas of historic centers (12%), redevelopment and improvement of the urban environment (9%), the refurbishment of residential housing (8%) and buildings (7%), and the repair of existing public housing stock (4.5%). For the current research, we analyzed 17 ARB projects that were implemented between 1999 and 2010 in vulnerable neighborhoods in Andalusian cities with more than 100,000 inhabitants [31] (p. 30). The ARB program overlapped in some places with the Areas in Need of Social Transformation program (hereafter ZNTS) and the EU Urban Community Initiative (URBAN I and II). This resulted in combinations of different area-based interventions that are of analytical interest for exploring potential impacts on health, given the differences in the policy frames of the programs.

The ZNTS program began in 1989 and involves intervention processes in areas with high levels of social vulnerability through collaboration between the regional government and local councils. To this end, local governments submit project proposals to the regional government each year. The proposals focus on social welfare policies and encourage collaboration with the local community. The program promotes social policy interventions, including actions on specific problems of social exclusion, as well as targeting education, health, employment, neighborhood relations, and the promotion of social participation. Investments are mainly directed toward areas of socio-family intervention (33%), educational support programs (28%), and the promotion of employment and labor market integration of vulnerable groups (23%) [31] (p. 32).

URBAN I (1994–1999) and URBAN II (2000–2006) combine interventions focused on achieving greater social integration, improving public spaces and facilities, and actions aimed at improving environmental sustainability and promoting economic activity. In general, the investments are more oriented toward promoting the economic development of areas (on average 25%), the sustainability of the urban environment (19%), infrastructure for participation (19%), and improving urban mobility (16%). Greater priority is given to place-oriented actions than those oriented toward households or people. Therefore, the central objective of this program is to improve the competitiveness and sustainability of the areas, as well as the social cohesion of the most vulnerable neighborhoods [31] (p. 31).

2.2. Quasi-Experimental Cohort Design: "Targeted" vs. "Control" Areas

We conducted a quasi-experimental study, based on the longitudinal statistics on survival and longevity in Andalusia, 2002–2016, as provided by the Institute of Statistics and Cartography of Andalusia. Specifically, we analyzed the impact of the urban regeneration processes that have been in operation for the last decade in Andalusia (Spain). The Andalusian Autonomous Community has had legislative and political autonomy since 1981, and therefore its government and administrative structure have the institutional power to implement public policies in a wide range of areas, including the design and implementation of policies to regenerate urban environments, the healthcare system, and public health. It also has strong powers in terms of social policies. To improve the quality of causal inferences about the potential impact of these policies on health, our quasi-experimental design was combined with prospective cohort data from the Andalusian population aged 40–70. This was individually followed up through statistical registers from 2002 up to 2016, in order to study mortality (thus, giving 15 years of follow-up information). Using this combined design, we compared the change in mortality risk between vulnerable urban areas where policies have been implemented, and other vulnerable areas where no such processes have been in place. The selection of areas was based on the identification of

vulnerable neighborhoods that was carried out by the Ministry of Transport, Mobility and Urban Agenda (formerly Ministry of Public Works) of the Spanish government, for Spanish cities with more than 50,000 inhabitants and provincial capitals, for the year 2001 [32]. As a part of the targeted group, we studied 161 urban areas (census tracts included in vulnerable neighborhoods) in 12 Andalusian cities (Table S1). For analytical purposes, the areas targeted for interventions were subdivided into four groups according to the combination of ABIs: 59 areas where only the ARB initiatives were in force (N = 878,585 person-time); 37 areas where ARB and URBAN programs overlapped (N = 473,830 person-time); 37 areas targeted by ARB+ZNTS (N = 608,422 person-time); and 28 areas with a combination of interventions from ARB+ZNTS+URBAN (N = 482,030 person-time). To complete our quasi-experimental design, we selected a control group of census tracts also included in socioeconomically deprived neighborhoods of the same cities. In the case of the ARB program, a total of 189 census tracts were randomly selected from among all the tracts included in vulnerable neighborhoods. These 189 tracts also had a synthetic index of socioeconomic vulnerability (ISVUN-SE) [33] similar to the areas targeted by a program (N = 3,378,003 person-time). For the combination of the ARB and URBAN programs, the control group was composed of 186 census tracts randomly selected among those that had an ISVUN-SE greater than 0.61 and that were included in vulnerable neighborhoods of the cities where both programs were in place (N = 2,940,835 person-time). For the combination of interventions with ARB+ZNST and ARB+ZNTS+URBAN, random selection was not possible because the high ISVUN-SE required made it unfeasible; therefore, all census tracts in the corresponding cities with an ISVUN-SE equal to or greater than 0.85 were selected as controls. Based on this criterion, the control group for ARB+ZNTS comprised 76 census tracts (N = 1,213,444 person-time) and 95 for ARB+ZNTS+URBAN (N = 1,493,906 person-time). Table 1 shows that the mean differences in the ISVUN-SE were not statistically significant between each type of intervention and its corresponding control group.

Table 1. Description of targeted and comparison areas according to ISVUN-SE.

| Areas | N | Mean | Std. Deviation | 95% Confidence Interval for Mean | | Anova | |
				Lower Bound	Upper Bound	F	*p*-Value
ARB	59	0.78	0.08	0.76	0.81	0.563	0.454
Control group	189	0.77	0.09	0.76	0.79		
ARB+URBAN	37	0.76	0.11	0.73	0.80	0.368	0.545
Control group	186	0.77	0.08	0.76	0.79		
ARB+ZNTS	37	0.89	0.08	0.87	0.92	1.698	0.195
Control group	76	0.91	0.04	0.90	0.91		
ARB+ZNTS+URBAN	28	0.88	0.10	0.84	0.92	2.080	0.152
Control group	95	0.90	0.03	0.89	0.90		

ISVUN-SE: Classification according to socioeconomic criteria. The range of possible values for this synthetic index is from 0 to 1, with higher values indicating greater vulnerability according to the components analyzed.

2.3. Preventable and Less Preventable Mortality

We used mortality as the dependent variable to analyze the effect of the policies. Although this variable represents an extreme health event and reflects exposure to specific risks and the accumulation of disadvantages through the course of a lifetime, it has been previously used in the assessment of the effects of urban regeneration policies, given its availability and reliability for comparative purposes [11]. In accordance with FCT, we studied preventable causes of death and causes of death where preventive knowledge is poorly developed. According to the hypotheses, urban regeneration programs should have a stronger impact on the former. We primarily analyzed the impact of policies on three groups of causes: preventable mortality, less-preventable mortality (based on the classification proposed by Mackenbach et al. [34]), and all causes of mortality combined. On the one hand, preventable causes included those that can be avoided by changing health-related

behaviors, those that can be avoided through the intervention of medical or health services, and those that can be avoided depending on both the adoption of healthy behaviors and medical intervention. Furthermore, for preventable mortality, we also included causes related to injuries (traffic accidents, accidental falls, and suicide), those associated with alcohol abuse, and those derived from some infectious and parasitic diseases, as they tend to be related to social exclusion problems that are the object of area-based policies. On the other hand, less-preventable causes of mortality include diseases that relate less to potential improvements in terms of material and non-material resources at the individual level, or to improvements to the neighborhoods' physical and social environment. These include certain types of cancer, such as pancreatic, liver, and stomach cancer, among others. The codes of the causes included in each group, according to the international classification of diseases (ICD-10), are specified in the Supplementary Materials.

2.4. Analyses

We estimated hazard ratios for individuals living in the four types of targeted areas relative to the control areas. We used quasi-Poisson regression models, given the over-dispersion of mortality data at the area level. The hazard ratios were adjusted by age (measured in five-year age groups), sex (male or female), education level (tertiary education as the reference category, illiterate, incomplete or no education, primary or secondary education), and period (2002–2006, 2007–2011, and 2012–2016). Regression models were estimated separately to assess the potential effect of each type of ABI, and the evaluation method used is equivalent to the difference-in-differences technique. For this purpose, an interaction term was introduced in the regression models between the period and the type of area-based interventions, in order to estimate the impact of interventions on mortality risk over time. The period of 2002–2006 was taken as a reference for assessing potential changes in trends, since most of the projects were implemented during this period, and their potential impact on mortality could therefore be expected to be at least medium-term, comparing this period with the last five-year monitoring period (2012–2016). The analyses were developed using the R program to prepare the data, and the IBM SPSS 23 statistical package to implement the quasi-Poisson regression models, for which the generalized linear models procedure was employed. We used robust estimates for the covariance matrix and Pearson's chi-square as the scaling parameter method.

3. Results

Table 2, Table 3, Table 4, Table 5 show the hazard ratios for mortality by different groups of causes for people aged 40–70, and the interactions between the ABI combinations and period. The results suggest that some target areas have a relatively higher risk of mortality from preventable causes than the comparison areas. This risk is significantly higher for ARB areas and those characterized by ARB+URBAN combined interventions (HRARB = 1.20; CI 95%: 1.07–1.34, HRARB+URBAN = 1.42; CI 95%: 1.24–1.62). Risks are also significantly higher in ARB areas compared with the control group for less preventable diseases (HRARB = 1.30; CI 95%: 1.07–1.57) and for all causes of mortality (HRARB = 1.16; CI 95%: 1.06–1.25). Residents in ARB+URBAN intervention areas, compared with residents in control areas, also have higher mortality risk from causes less sensitive to prevention (HRARB+URBAN = 1.40; CI 95%: 1.10–1.78), from all causes (HRARB+URBAN = 1.36; CI 95%: 1.24–1.51) and from those causes where prevention is related to behavioral change and medical intervention (HRARB+URBAN = 1.49; CI 95%: 1.28–1.73).

Table 2. Hazard ratios for people aged 40–70 and ARB interventions in vulnerable urban areas of Andalusia.

	Preventable				Less Preventable				All Causes				Behavioral Change and/or Medical Intervention				Medical Intervention				Injuries			
	HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%		
ARB (ref. Comparison Areas)	1.20	1.07	1.34	**	1.30	1.07	1.57	**	1.16	1.06	1.25	***	0.00	1.26	1.11		0.06	0.69	0.46		1.24	0.80	1.93	
Period (ref. 2002–2006)																								
2007–2011	0.92	0.85	1.00	*	1.01	0.88	1.17		0.96	0.91	1.02		0.03	0.90	0.82		0.36	0.90	0.72		1.09	0.80	1.48	
2012–2016	0.83	0.76	0.90	***	1.00	0.87	1.15		0.92	0.87	0.97	**	0.00	0.86	0.78		0.02	0.76	0.60		0.77	0.56	1.07	
ARB*Period																								
ARB*2007–2011	0.97	0.82	1.14		0.88	0.66	1.16		1.05	0.93	1.18		0.67	0.96	0.79		0.07	1.62	0.96		0.78	0.41	1.47	
ARB*2012–2016	0.95	0.80	1.12		1.03	0.78	1.34		1.03	0.92	1.16		0.13	0.86	0.71		0.00	2.21	1.32		0.45	0.20	1.00	*
Goodness of Fit																								
Log Likelihood	−15,018.92				−6819.88				−24,947.37				−11,343.24				−3043.42				−1781.11			
Akaike's Information Criterion (AIC)	30,067.84				13,669.77				49,924.75				22,716.49				6116.85				3592.21			
Bayesian Information Criterion (BIC)	30,207.60				13,809.52				50,064.50				22,856.24				6256.60				3731.97			
Likelihood Ratio Chi-Square	1650.93	***			868.31	***			2430.04	***			1739.90	***			135.63	***			65.10	***		
N deaths	18,276				4560				41,670				9111				1826				734			

HR = Hazard ratios adjusted for age groups, sex, and education level. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 3. Hazard Ratios for people aged 40–70 and ARB+URBAN interventions in vulnerable urban areas of Andalusia.

	Preventable				Less Preventable				All Causes				Behavioral Change and/or Medical Intervention				Medical Intervention				Injuries			
	HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%	
ARB+URBAN (ref. Comparison Areas)	1.42	1.24	1.62	***	1.40	1.10	1.78	**	1.36	1.24	1.51	***	1.49	1.28	1.73	***	1.18	0.79	1.77		0.91	0.47	1.77	
Period (ref. 2002–2006)																								
2007–2011	0.90	0.83	0.98	*	1.02	0.89	1.16		0.97	0.92	1.03		0.87	0.79	0.95	**	0.73	0.57	0.92	**	1.18	0.86	1.61	
2012–2016	0.81	0.74	0.88	***	1.06	0.93	1.21		0.92	0.87	0.97	**	0.79	0.71	0.87	***	0.73	0.57	0.92	**	0.83	0.59	1.17	
ARB+URBANBI*Period																								
ARB+URBANBI*2007–2011	0.87	0.71	1.07		0.73	0.51	1.04		0.88	0.76	1.02		0.92	0.73	1.16		0.74	0.39	1.43		1.35	0.58	3.12	
ARB+URBANBI*2012–2016	0.79	0.64	0.97	*	0.79	0.56	1.11		0.84	0.72	0.97	*	0.76	0.60	0.97	*	0.70	0.36	1.36		1.59	0.67	3.78	
Goodness of Fit																								
Log Likelihood	−13,239.47				−6051.60				−21,884.74				−9971.31				−2537.85				−1576.07			
Akaike's Information Criterion (AIC)	26,508.95				12,133.21				43,799.48				19,972.63				5105.71				3182.14			
Bayesian Information Criterion (BIC)	26,646.96				12,271.22				43,937.49				20,110.64				5243.72				3320.16			
Likelihood Ratio Chi-Square	364.30	***			108.52	***			796.46	***			1150.46	***			12.42				74.20	***		
N deaths	17,055				4205				38,131				8879				1652				670			

HR = Hazard ratios adjusted for age groups, sex, and education level. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 4. Hazard Ratios for people aged 40–70 and ARB+ZNTS interventions in vulnerable urban areas of Andalusia.

	Preventable				Less Preventable				All Causes				Behavioral Change and/or Medical Intervention				Medical Intervention				Injuries		
	HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%	
ARB+ZNTS (ref. Comparison Areas)	1.04	0.90	1.20		1.26	0.95	1.66		1.11	1.00	1.24		0.96	0.81	1.15		0.79	0.45	1.40		1.60	0.87	2.95	
Period (ref. 2002–2006)																								
2007–2011	0.85	0.75	0.96	*	0.98	0.79	1.23		0.93	0.85	1.01		0.80	0.69	0.92	**	1.16	0.77	1.73		0.93	0.53	1.63	
2012–2016	0.84	0.75	0.95	**	1.02	0.82	1.27		0.93	0.85	1.02		0.82	0.72	0.95	**	1.16	0.78	1.74		0.75	0.42	1.34	
ARB+ZNTS*Period																								
ARB+ZNTS*2007–2011	1.08	0.88	1.33		0.81	0.54	1.20		0.97	0.83	1.13		1.21	0.94	1.55		0.95	0.44	2.08		0.92	0.39	2.16	
ARB+ZNTS*2012–2016	1.00	0.81	1.23		0.79	0.54	1.17		0.92	0.79	1.07		1.15	0.89	1.47		0.87	0.40	1.91		0.68	0.27	1.71	
Goodness of Fit																								
Log Likelihood	−7584.87				−2884.29				−11,930.22				−5723.35				−1148.95				−744.32			
Akaike's Information Criterion (AIC)	15,199.75				5798.57				23,890.44				11,476.69				2327.91				1518.65			
Bayesian Information Criterion (BIC)	15,327.01				5925.83				24,017.70				11,603.95				2455.17				1645.91			
Likelihood Ratio Chi-Square	617.14		***		361.56		***		1244.83		***		553.20		***		64.13		***		51.68		***	
N deaths	8357				1849				18,113				3801				691				337			

HR = Hazard ratios adjusted for age groups, sex, and education level. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 5. Hazard ratios for people aged 40–70 and ARB+ZNTS+URBAN interventions in vulnerable urban areas of Andalusia.

	Preventable				Less Preventable				All Causes				Behavioral Change and/or Medical Intervention				Medical Intervention				Injuries			
	HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%			HR	CI 95%		
ARB+ZNTS+URBAN (ref. Comparison Areas)	1.03	0.89	1.20		1.12	0.87	1.44		1.06	0.96	1.18		0.99	0.84	1.18		1.18	0.74	1.89		1.15	0.65	2.02	
Period (ref. 2002–2006)																								
2007–2011	0.93	0.84	1.03		0.84	0.70	1.02		0.96	0.89	1.03		0.90	0.80	1.02		0.93	0.66	1.31		0.88	0.58	1.34	
2012–2016	0.82	0.73	0.91	***	1.03	0.87	1.23		0.91	0.85	0.99	*	0.81	0.71	0.91	***	0.82	0.58	1.17		0.55	0.35	0.89	*
ARB+ZNTS+URBAN*Period																								
ARB+ZNTS+URBAN*2007–2011	0.95	0.77	1.18		1.12	0.77	1.61		1.00	0.86	1.17		0.99	0.77	1.27		0.77	0.39	1.55		0.93	0.41	2.12	
ARB+ZNTS+URBAN*2012–2016	1.07	0.87	1.32		0.93	0.65	1.33		1.00	0.86	1.17		1.16	0.91	1.48		0.68	0.33	1.40		1.08	0.44	2.65	
Goodness of Fit																								
Log Likelihood	−8854.47				−3591.49				−13,775.89				−6814.33				−1412.57				−931.26			
Akaike's Information Criterion (AIC)	17,738.95				7212.98				27,581.79				13,658.65				2855.14				1892.53			
Bayesian Information Criterion (BIC)	17,867.31				7341.35				27,710.16				13,787.02				2983.51				2020.89			
Likelihood Ratio Chi-Square	560.23	***			284.20	***			1193.58	***			757.98	***			84.50	***			42.76	***		
N deaths	10,443				2252				21,962				5268				860				397			

HR = Hazard ratios adjusted for age groups, sex, and education level. *** $p < 0.001$; * $p < 0.05$.

When analyzing the existence of possible time-related effects, the results consistently point to a trend toward a reduction in mortality risk in the group of all preventable diseases, from the period 2002–2006 to 2012–2016. However, no significant change is observed in the group of diseases less sensitive to prevention, which is in line with the fact that there is little capacity to influence the causes of death included in this group. More specifically, the results of the analyses conducted for the ARB areas and their controls (Table 2) indicate a significant reduction in the risks of mortality from preventable diseases (HR2012–2016 = 0.83; CI 95%: 0.76–0.90) and all causes of mortality (HR2012–2016 = 0.92; CI 95%: 0.87–0.97). The results in Table 3 indicate a significant reduction in mortality in the last analyzed period compared with the first, for preventable causes (HR2012–2016 = 0.81; CI 95%: 0.74–0.88), those preventable by behavioral change (HR2012–2016 = 0.79; CI 95%: 0.71–0.87), those preventable mainly by medical treatment (HR2012–2016 = 0.73; CI 95%: 0.57–0.92), and for all causes of death (HR2012–2016 = 0.92; CI 95%: 0.87–0.97). In the case of the analyses for ARB+ZNTS (Table 4), a reduction in the risk of preventable mortality (HR2012–2016 = 0.84; CI 95%: 0.75–0.95) and behavioral change (HR2012–2016 = 0.82; CI 95%: 0.72–0.95) is observed in the last five-year period compared with the first. In the areas analyzed in Table 5, which probably represent the most vulnerable areas in terms of the ISVUN-SE, a reduction in mortality risk is seen in the last analysis period for all preventable causes (HR2012–2016 = 0.82; CI 95%: 0.73–0.91), for causes preventable by behavioral change (HR2012–2016 = 0.81; CI 95%: 0.71–0.91), for injuries (HR2012–2016 = 0.55; CI 95%: 0.35–0.89), and for all causes combined (HR2012–2016 = 0.91; CI 95%: 0.85–0.99).

To explore whether the interventions have any potential impact on mortality risk, we should consider the results of the interactions between the combination of interventions and periods. According to the results shown in Table 2, the ARB program does not seem to have an impact on the risk of mortality from any type of preventable causes, except for injuries. In this group of causes, there is a greater reduction in risk for residents in the intervention areas, compared with the control areas (HRARB*2012–2016 = 0.45; CI 95%: 0.20–1.00). The results in Tables 4 and 5 indicate that the combinations of the programs ARB+ZNTS and ARB+ZNTS+URBAN do not seem to significantly influence the evolution of mortality risk of residents in the targeted areas, compared with those in the control areas. However, the results suggest that in the areas where ARB and URBAN interventions overlap (Table 3), there are significant decreases in mortality risk in the last period analyzed. These decreases are notably more pronounced than those in the comparison areas for the group of preventable causes (HRARB+URBAN*2012–2016 = 0.79; CI 95%: 0.64–0.97), those preventable by behavioral change and/or health intervention (HRARB+URBAN*2012–2016 = 0.84; CI 95%: 0.72–0.97), and for all causes (HRARB+URBAN*2012–2016 = 0.76; CI 95%: 0.60–0.97). The results indicate that there are no significant trends in the group of causes that are less sensitive to prevention. Figure 1 provides a graphic illustration of the interactions for the three main groups of causes. These graphs show that it is only in the case of the combination of ARB+URBAN interventions that mortality from all causes and from those most sensitive to prevention decreases significantly, compared with the areas where no intervention has taken place.
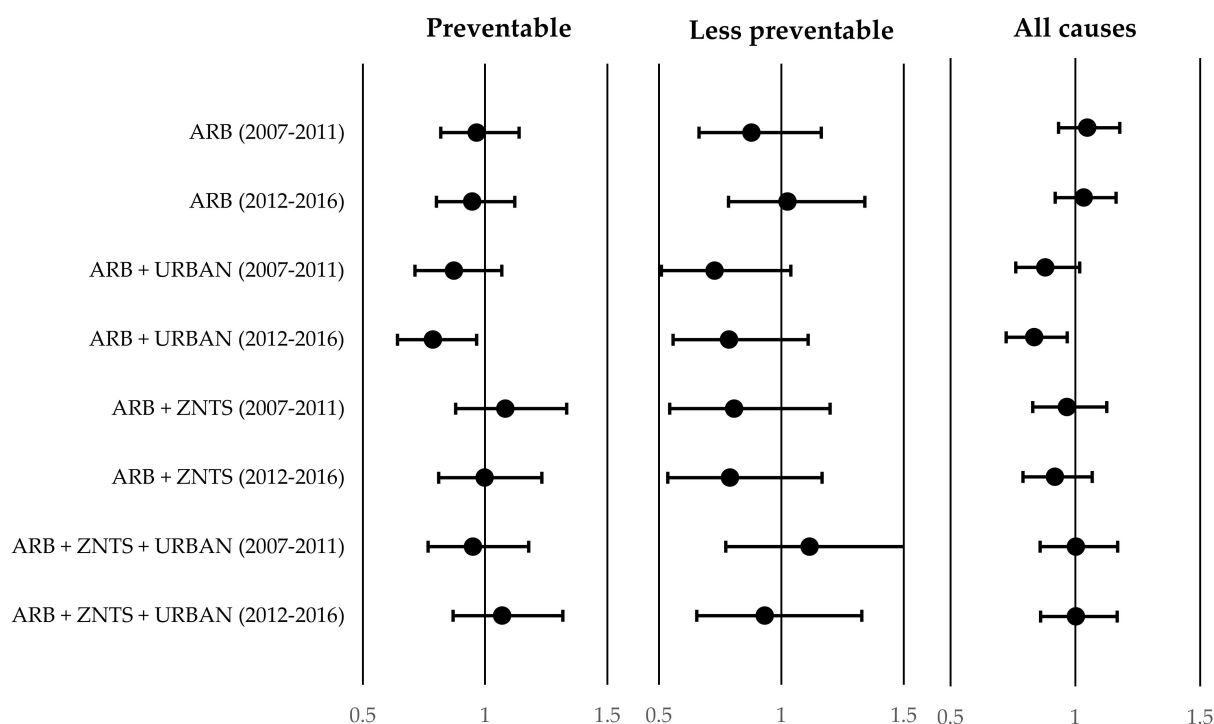
Figure 1. Combination of interventions and evolution of hazard ratios (people aged 40–70).

4. Discussion

This article presents an analysis of the possible impacts on mortality risks of different combinations of ABIs developed in vulnerable areas of 12 cities in Andalusia (Spain), during the period from 1999 to 2012. To minimize the possible confusion in the attribution of causality that could be introduced by the population change that may have occurred in the targeted areas, our research is based on a longitudinal data source through which we followed the population recorded on the census in Andalusia in 2002, up to 2016. Specifically, we studied the impact on premature mortality, focusing the analyses on the sector of the population between 40 and 70 years of age.

In the present study, we have tried to deal with the main methodological limitations of studies assessing the impact of ABIs on health [10,11,19], specifically:

(1) The selection of outcome variables and the specification of our main hypotheses were guided by the propositions of the fundamental cause theory, with the aim of addressing some of the shortcomings in the theoretical formulation of this type of research.

(2) We have tried to consider a sufficiently extended temporal space, using a longitudinal follow-up of the whole population for 14 years. The potential effects of the interventions can thus be observed for the whole population, rather than on limited samples of it.

(3) Through implementing a quasi-experimental cohort design, we have tried to deal with the problems introduced by the change in the composition of the population of the targeted areas, evaluating the trends in the changes that have occurred in these areas in relation to those produced in a group of comparison areas during the same period. In this way, we aimed to enhance the causal inference of the evaluation.

The results reflect how a combination of interventions can contribute to generating impacts on preventable mortality in some cases. Thus, considering the first hypothesis (H1), ABIs seem to moderate the risk of mortality for residents in vulnerable urban areas where more holistic interventions have been implemented—that is, where different urban regeneration programs converge and where the intervention agenda is more diverse

and/or comprehensive. Specifically, of all the combinations of ABIs analyzed, the ARB and URBAN programs are the ones with the highest diversity indexes in the orientation of their interventions: 0.49 and 0.69 on a scale of 0–1 respectively [31] (p. 30). In addition, their design is characterized by a greater degree of comprehensiveness, with their actions being oriented toward a greater number of areas previously defined as having problems. More specifically, ARB combines actions focused on improving the habitability of housing and addressing social integration problems, while URBAN projects combine actions aimed at environmental sustainability, socio-economic improvement, the employability of residents, and the improvement of public space. The main result of our study points to the reduction of preventable mortality in those areas where ARB and URBAN interventions were combined. This is in line with previous research, suggesting that policies for urban areas can contribute to reducing health disparities when interventions are implemented by combining different policy frames—that is, when actions focused on improving the living conditions of individuals and their families converge with those aimed at regenerating the physical space and the socio-economic environment of neighborhoods [17].

In relation to our second hypothesis (H2), the findings are in line with the assumptions of the FCT. The reduction in mortality risk observed in the case of the areas targeted by the ARB+URBAN programs is only statistically significant for preventable causes. No such reduction is found for the less preventable causes that theoretically should not be affected by the intervention or the improvement of the "flexible resources" that area-based policies would provide (H3). According to Clouston et al. [35], the group of less preventable causes of mortality is found in what they call the "natural mortality" stage, characterized by a random distribution at the population level and the absence of clear social patterns. It would not be until successive stages, in which new preventive capacities are developed for this type of mortality, that it would be distributed unequally at the population level, giving rise to social patterns that could be altered or modified depending on the institutional interventions that might influence the pre-distribution of flexible resources in each society. In our study, we use this theoretical assumption to ensure that the reduction in preventable mortality observed in ARB+URBAN areas is not simply due to a chance effect. If this had been the case, it would have also been replicated in the non-preventable causes.

If we look at the results for the groups of causes according to the type of prevention, we can see that the preventable mortality that seems to be influenced by the ARB+URBAN interventions relates to causes where prevention can be tackled through the joint action of changing health-related practices and particular medical interventions. However, those that depend exclusively on medical treatment do not seem to be affected, in general, by the combination of this type of program. This is consistent with the fact that access to medical treatment in Andalusia is universal. Although there may be disparities in accessibility, these do not seem to be of a magnitude that is related to significant excess mortality in the vulnerable areas targeted for this type of cause, as shown by the fact that there are no significant differences between areas for this type of cause of mortality.

The combination of ARB+URBAN involves areas where a decrease in the risk of mortality from preventable diseases is observed. This is mostly in vulnerable urban areas belonging to the historic centers of the main Andalusian cities. In these areas, there was a marked transformation of the public and social spaces, not only directly due to the interventions, but also to the attraction of strong private sector investment during and after intervention. The confluence of the two programs has led to intense activity in housing regeneration and the improvement of public spaces in these areas, and it has also been characterized by the implementation of actions focused on improving environmental sustainability, promoting economic transformation, and addressing relevant social problems, including actions aimed at health. Therefore, the contextual characteristics of the historic centers themselves may have contributed to triggering processes of transformation in these vulnerable areas, with greater intensity than in other parts of the periphery of the cities. Accordingly, it seems necessary to analyze the impact of the ABIs in terms of the "contextual" nature of the areas where they are implemented. Interventions in historic

city centers may trigger different processes to those that might occur in other areas of the city that could explain the improvements in health. In our case, the result is apparently positive, and could be interpreted directly as a possible effect of the intervention, or indirectly, through the interaction of the intervention with other social processes that may be influencing the health of residents. For example, it could be the case that the interventions produce a greater change in the characteristics of the resident population in historic centers, orienting them toward "more innovative cultural scenes", making them more permeable to cultural changes and to the adoption of preventive knowledge [36]. In this case, ABIs would contribute to health improvement because the original population of the neighborhood could be modifying their practices in line with the influence exerted by the collective expression of new healthy practices more prevalent among people who moved into the neighborhood after the intervention. These new residents tend to be younger, with higher socioeconomic status, and more structured social preferences toward healthy choices and toward promoting the sustainability of the urban environment. A mechanism characterized by the "assimilation" of the new residents' health-related practices by the original population could thus be at work. It is also necessary to recognize that in more densely populated cities, the phenomenon of gentrification may have pushed more vulnerable residents out of their original houses. However, we think that our results would capture part of the effect of change in health-related behaviors of the original population, because they are based on an analysis of the cohort of people living in the areas in 2002 (close cohort before or at the start of the intervention). It is thus unlikely that the reduction in avoidable mortality is due to a change in the composition of a healthier population, as the results are based on a prospective comparison of the same individuals over the three five-year periods studied. This result would be in line with previous findings on the diffusion of preventive behavior and practices at the population level [37,38]. However, the combination of ARB+ZNTS+URBAN was mostly implemented in the most vulnerable peripheral neighborhoods of cities, where the process of population change has not been as intense as in the historic centers. This could be an explanation for why no significant changes in the risk of mortality from preventable diseases are observed in these areas, despite the ARB and URBAN programs having been in force. Nevertheless, the assimilation mechanism hypothesis would need to be tested in future evaluations of the health impact of ABIs.

Lastly, it should be noted that the potential effects of reductions in mortality from preventable causes would mainly be due to behavioral changes and medical interventions, with the effects for the most relevant group in terms of magnitude being related to changes in health-related habits and practices. This result implies the desirability of lengthening the time frame of impact evaluations of ABIs on mortality because, for changes in healthy practices and behaviors to translate into significant reductions in mortality, longer time intervals would be needed to determine the causal attribution of such effects.

5. Conclusions

Strengthening health assets by improving economic promotion, physical rehabilitation, social welfare, and improving the urban environment can facilitate the development of new mechanisms that link social inequalities and health. These mechanisms are referred to by the FCT as flexible resources and operate at both the individual and the contextual level. Theoretically inspired studies on the impact on health from area-based policies are still very scarce in the international literature. Thus, the current research constitutes an effort to advance theoretical and methodological issues in order to understand the link between different interventions. These aim to improve the opportunity structure of the most deprived areas of urban space by increasing the availability of "flexible resources" for their residents and identifying the most relevant risk and protective factors for health to improve policy actions in the urban environment. More detailed analyses of the types of ABI frames and the role of initiatives that aim to improve the environmental and social sustainability of deprived urban areas would need to be undertaken in the future.

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