

Article

## Greenery and Urban Form vs. Health of Residents: Evaluation of Modernist Housing in Lodz and Gdansk

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### Abstract

Urban forms can have numerous direct and indirect effects on the health of residents. This article focuses on the relationship between health and urban form, in particular the role of green open spaces. The goal is to identify criteria for evaluating the impact of physical forms such as streets and open spaces, green infrastructure, and built structures on urban health. These criteria are then used to identify paths for the redevelopment of modernist housing estates with the aim of improving living conditions. This challenge remains particularly significant in Poland and Eastern Europe, where a large share of the urban population lives in modernist blocks of flats. First, we examine the modernist housing concept in Europe and Poland and the guiding principles for their development, including the role of green, open spaces. Then, we refer to several studies on urban health to identify normative factors that define the open space design conditions in modernist housing estates. We apply the typo-morphological approach with qualitative and quantitative assessment of building forms and forms of green open spaces to examine the structures of two modernist housing estates in Poland: Lodz and Gdansk. We evaluate their living conditions, especially the organisation of outdoor space, in terms of their impact on the health of residents. A comparison of the two housing estates reveals common factors defining the relationship between urban form and health.

### Keywords

Gdansk; healthy cities; Lodz; modernist housing; Poland; urban form; urban morphology

### Issue

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### 1. Introduction

The global discourse on the design of healthy cities emphasises the need to focus on both the health and well-being of citizens (World Health Organization, 2014, 2020). Recommendations for how to proceed can be found in numerous research articles, books, and documents published by international organisations (e.g., World Health Organization, 2020). Some of these works provide comprehensive guidelines based on research (Forsyth et al., 2017; Sarkar et al., 2014) and address a broad range of topics at neighbourhood, city, and

regional scales. Some of the recommendations focus on urban form, others on the strategic process of adjusting the urban fabric to improve human well-being. One of the concepts that has attracted significant attention is the integration of green infrastructure in urban space, which is considered to play a principal role in improving living conditions (Forsyth et al., 2017; Marselle et al., 2019).

The founders of the modern movement also emphasised greenery and open space as elements contributing to urban health (Le Corbusier, 1943). This type of residential development became widespread in Eastern

Europe after the Second World War. It offered decent housing conditions to large numbers of urban residents. Modernist estates still satisfy the housing needs of a wide range of inhabitants in Eastern Europe. For instance, around 300,000 of the 664,000 inhabitants of Lodz (Poland) live in modernist blocks of flats (Statistics Poland, 2021). Polish housing estates support a diverse social structure and are not subject to the stigmatisation associated with similar developments in Western Europe (Szafrńska, 2013). However, due to their gradual deterioration, they are now in need of refurbishment and adjustment to changing societal requirements.

In this article, we apply a framework for evaluating a healthy environment informed by contemporary research and overlap this approach with the original modernist ideas. We look closely at the original ideas behind modernism. We then analyse their implementation and evolution over time in two Polish housing estates: Zgierska-Stefana in Bałuty (Lodz), and Przymorze (Gdansk). Both housing estates were built after 1971, during the period of industrialised, large-scale housing production. The analysed residential typologies followed some of the original concepts of Le Corbusier and Walter Gropius, in terms of scale, open space provision, and segregation of transportation. Since then, societal, political, and economic conditions have altered some of the original concepts. We trace these factors while examining the organisation of open space and look at their consequences on citizens' health. Our analysis enables us to verify how the original theoretical concepts were implemented in real life, and how they have been adapted to the housing market since the political changes of 1989–1990. Our purpose is to fill a gap in the existing research, by proposing a new approach to evaluating modernist housing estates in terms of whether and to what extent they provide healthy living conditions. Our primary research question is how modernist design assumptions overlap with healthy living conditions and, as a consequence, what recommendations might be made for the examined estates to improve the health of residents.

## 2. Research Background

The topic defined in this article fills a gap in the current subject literature. A literature search in Scopus using the keywords [( TITLE-ABS-KEY ( housing AND estates ) AND TITLE-ABS-KEY ( health ) AND TITLE-ABS-KEY ( greenery ) ] returns a limited number of entries (eight). From this group, we excluded studies using IT-based methods and those focused on locations outside Europe. In the remaining five studies, one by Battisti et al. (2019) examined the health-related ecosystem services and disservices in Berlin, and another, by the same authors, considered ways of managing urban greening to improve the well-being of other European cities (Battisti et al., 2020). Kłopotowski (2017) looked at the evolution of green areas in housing estates. Schmid and Säumel (2021) examined perceptions of residential greenery in

Berlin. Finally, He et al. (2020) used pedestrian-centred photographs to learn about the relationships between street greenery and the physical activities of elderly residents. The Polish studies that address issues related to the organisation of outdoor space in modernist housing estates deal with urban greenery (Skibniewska et al., 1979; Szulczewska, 2015) and forms of recreation areas (Lis, 2011). To the best knowledge of the authors, there are no previous studies focused on the overlap between the design principles of modernist housing estates and the concept of urban health.

### 2.1. Modernist Housing Estates: Design Principles and History

The aim of improving sanitary and living conditions in cities has been a focus for over a century. The idea of the role of access to green space was at the core of modern planning discourse from the very beginning (Le Corbusier, 1943; Mumford, 2018) and planning debates among the hygienist movement, as a reaction to progressive industrialisation, and resulted in the adoption of new building laws at the beginning of the 20th century. For example, in Berlin (Germany), a new construction law was adopted in 1925 which imposed the requirement of integrating more open spaces in courtyards. Another major goal was the building of residential estates to improve living conditions. This was also taken as an opportunity to look for ways to integrate greenery into urban areas. We can trace these objectives in the works of modernist forerunners, such as Tony Garnier's *Une Cité Industrielle*, drafted in 1901 and finally published in 1917. A synthesis of contemporary social and technical trends, the project proposed explicit functional zoning. In order to create appropriate living conditions, a continuous green space, open for everybody and containing all the necessary facilities, was to surround residential structures (Mumford, 2018, pp. 70–71). We find a similar discourse in American debates from the beginning of the 20th century, where ideas on how to deal with the decay of central cities proposed decentralisation of industrial development, improvements of traffic systems, and the introduction of greenery to the centres (Mumford, 2018, p. 122). The possibility of safe pedestrian circulation along with the provision of greenery was central to the design by Clarence Stein and Henry Wright for Radburn residential superblocks (Mumford, 2018, p. 130). Both concepts were adopted by modernist urbanism.

All these ideas influenced the important series of projects by Le Corbusier, starting from the "Contemporary City for Three Million" (*Ville Contemporaine*), his vision of future urban development published in 1922 in the avant-garde journal *L'Esprit Nouveau* (founded by Le Corbusier together with the artist Amédée Ozenfant). The concern to improve living conditions is visible especially in the form of the planned residential development, which included linear apartment blocks placed in park-like green settings as well as massive skyscrapers

containing offices, all served by various transportation modes: a system of roads, underground railway, and an airport (Mumford, 2018, pp. 148–149). Other architects belonging to the “modern movement” (the name used by Eric Mendelsohn in 1931), such as Jacobus Oud in the Netherlands and Bruno Taut in Berlin, designed large residential estates for workers applying the garden cities and Bauhaus ideas. However, unlike Le Corbusier’s massive skyscrapers, these low-rise ensembles featured carefully organised green spaces. We find a continuation of the garden city emphasis on public access to green open spaces for recreation and social interactions in the works of Ernst May.

All these ideas became key for the Congrès International d’ Architecture Moderne (CIAM) and found full expression in its activities, especially in the Fourth Congress on the Functional City in 1933, which took place on board of the ship *Patrice* travelling from Marseille to Athens. The post-congress publication of the Athens Charter contained a clear message, which significantly affected the development of post-war cities (Le Corbusier, 1943). Its postulates emphasise the use of greenery to separate functional zones and as a tool to reduce the negative impacts of various adjacent activities. The introduction of vegetated areas aimed to loosen the structure of urban cores and satisfy citizens’ needs for recreation (Solarek, 2015, p. 31). The founders of Modernism advanced these concepts, by looking for a balance between maintaining the proper density and open space provision. Walter Gropius promoted the construction of communal apartment buildings in the form of massive, multi-storey buildings set in large green open spaces, such as his proposal for an 11-floor slab high-rise for the Spandau district in Berlin (1928, unbuilt) or his famous diagrams published in 1929 presenting the relationships between the building heights, distribution, and the amounts of light and greenery between (Mumford, 2018, pp. 159–160).

Another concept modelled after the Plan for Helsinki of 1918 by Eliel Saarinen and Erich Gloeden was the introduction of green park strips, which divided districts while forming a continuous system and serving to reduce densities. Each semi-autonomous district would have its own centre, with a range of necessary services. The plan became influential; it found its reflection in the plan for Moscow accepted in 1935. This plan featured new housing estates with six- or seven-floor blocks of reduced densities compared to other Moscow districts (200 people per acre) and a full range of communal facilities, including mass transportation (Mumford, 2018, p. 168).

The post-war structures built in Europe tended to follow the path indicated by CIAM architects. Estates such as Churchill Gardens, Westminster, London, or Hansaviertel in West Berlin, replaced war-torn districts. They featured extensive green spaces and massive, widely spaced residential structures. During the 1960s and 1970s, large-scale housing complexes built with industrialised technologies spread out across Europe. Many of these

structures were modelled after the *Unité d’Habitation de Marseilles* (1946) designed by Le Corbusier. In Poland, like everywhere in Eastern Europe, the modernist tradition also prevailed after the initial phase of post-war construction of neo-classical or socio-realistic residential complexes. Early projects, including Warsaw estates such as Rakowiec or Żoliborz, some of which were started before the Second World War, or Młynów, Muranów and Wierzbno (started in the 1950s), applied the concept of the so-called “social neighbourhood” developed by the Warsaw Housing Cooperative and Social Construction Company. These works, conducted during the Nazi occupation of Poland, continued earlier activities by the Polish Housing Reform Society, which from 1928 worked on the development of social housing.

In later years, Polish cities largely implemented the modernist approach, gradually introducing large-scale prefabricated concrete construction systems (Chomańska, 2018). Eastern European cities continued a functionalist approach until the political transformation of the 1990s. High-rise buildings allowed the possibility of leaving vast open spaces, which were conceived as green areas compensating for the lack of nature in cities (Nyka, 2017). Greenery became widely recognised as an element serving to isolate functional zones, in the form of large open spaces or stripes accompanying streets and parking lots, protecting against the negative impacts of transportation. The share and dimensions of green isolating elements were defined in subsequent norms (1964, 1974, after Skibniewska et al., 1979, p. 13). For example, according to the regulation of 1974 defining the net size of green areas in multifamily housing, two conditions had to be fulfilled: Green areas should be 50% of the total net area or larger, and the amount of green area per resident should be more than 8 m<sup>2</sup> (Korzeniewski, 1989, p. 192). As a result, modernist housing estates often offer ample greenery but not necessarily spaces on a human scale (Solarek, 2015). The open space lacks organisation and definition into private, neighbourhood, semi-public, and public zones and facilities for pedestrians. There was also little consideration of human activity and the creation of spaces that could foster such activity (Skibniewska et al., 1979, p. 12), both in the physical dimension (environmental conditions), and through the shaping of an appropriate information sphere (the meanings of permanent and temporary elements of equipment). Another guiding principle was the location of recreational areas in direct proximity to the residences. As a result, the greenery accompanying housing structures was combined with green areas surrounding schools and recreational facilities. These conditions are the same as the requirements defined for walkable space.

## 2.2. *Healthy Cities*

Health benefits that stem from the provision of green spaces include urban cooling, physical fitness



opportunities, ecological education, improvement of water and air quality, and protection from traffic pollution (Hartig et al., 2014; Heerwagen, 2009; Schäfer et al., 2017; Wells & Rollings, 2012) and noise (Koprowska et al., 2018; Peris & Fenech, 2020). The presence of greenery also contributes to mental health, providing relaxation, reducing stress, and enabling mindfulness and various recreational activities (Alcock et al., 2014; Coon et al., 2011; Davis, 2004; Grahn & Stigsdotter, 2010; Gruebner et al., 2017; Hartig et al., 2003; Marselle et al., 2019). Greenery has beneficial effects on longevity and lowers mortality (Kühn et al., 2017). A variety of green spaces can form a system that creates opportunities for various users (Forsyth & Musacchio, 2005, pp. 3–5; Harnick, 2006; Maller et al., 2009). Moreover, overlapping and connecting variegated activities multiplies their benefits for specific users. Both parks and neighbourhood green spaces should be easily available for people with mobility problems and the socially excluded (Harnick, 2006, p. 57). Forsyth et al. (2017) defines normative guidelines for designs, which should consider the following features:

1. Access, both physical and visual. The optimum distance to green spaces should range from 400 to 800 m from all the premises in the residential estate. The proximity of public transportation can further increase access options.
2. Connections between green open spaces and recreational facilities should contribute to the system. These might include tree-lined streets, greenways, boulevards, and separate green trails or paths.
3. A variety of forms of both green and recreational areas should expand the range of available activities. Vegetated spaces may also provide other environmental benefits, such as water retention or community gardening. They can serve different users throughout the day, with various activ-

ities catering to the needs of multiple differentiated users.

The ways we use the environment are both the outcome of human evolution and the effects of socioeconomic, environmental, and cultural processes and factors (Appleton, 1975; Forsyth & Musacchio, 2005; Orians, 1986; Orians & Heerwagen, 1992; Wilson, 1984; Tveit et al., 2018; Zube & Pitt, 1981). As little as five minutes of outdoor activities per day is sufficient to improve our mental health, especially self-esteem and mood (Barton & Pretty, 2010). Research confirms that physical activities such as walking or running are considered more valuable when performed in natural conditions (Bowler et al., 2010, pp. 1–9). They provide more benefits in terms of stress reduction, raising mood, and energy levels (Coon et al., 2011), and improving some psychological disorders (Forsyth et al., 2017; Thompson, 2019). Environments that are safe from traffic and provide public spaces, recreational facilities, and greenery are especially suitable for young children (0–7 years old). This is confirmed by parental perceptions of the general physical health, emotional maturity, social competence, and cognitive and language skills of children (Christian et al., 2015, pp. 30, 33). In case of limited provision of open space, small pocket parks, rows of trees lining streets, and even views of greenery from windows can improve the well-being of residents (Brown et al., 2013; Forsyth et al., 2017; Tennessen & Cimprich, 1995; Ulrich, 1984). Table 1 presents selected forms of urban greenery using the millennium ecosystem assessment, a commonly recognised framework for evaluating the benefits of green infrastructure (Millennium Ecosystem Assessment, 2005).

Sarkar et al. (2014) examined the multi-scale associations between individual-level health outcomes and features of the built environment. They proposed a set of indicators that covers the neighbourhood-level

**Table 1.** Forms of urban greenery in residential estates versus their role and ecosystem services.

ES	Green infrastructure role/type	Urban parks, including pocket parks	Recreational facilities	Trails, paths, greenways	Tree rows, tree canopy	Greenery near buildings
P	Access resources	X		X		
R	Water retention, stormwater infiltration, cleaning	X			X	X
	Protection from heat	X			X	X
	Buffers from traffic/noise	X			X	X
	Climate mitigation	X			X	X
C	Physical activity	X	X	X		
	Socialising	X	X			
	Psychological wellbeing	X	X		X	X
	Safety from traffic			X		

Notes: ES—ecosystem services; P—provisioning services; R—regulating services; C—cultural services. Source: Authors' own work using the evaluation by Forsyth et al. (2017).

determinants of health, such as density and intensity, diversity, destination accessibility, street network morphology and connectivity, and access to public transit stops and stations, as well as active transport and pedestrian-oriented design. For the purposes of the present study, we initially narrowed the original rich methodology defined in their study to factors that refer directly to the physical environment:

- Factor N1—Density/intensity: Studies examining the associations between attributes of the built environment, health behaviour, and health outcomes employ diverse measures of density and intensity. Population density and residential density are the most common measures that correlate features of the built environment with active behaviour and, therefore, health. As the land use density increases, trip origins are brought closer to one another, resulting in greater accessibility to the service destination. High-density compact neighbourhoods shorten trip lengths and increase the number of trips.
- Factor N2—Diversity: Diversity or land use mix reflects the number of different land uses as well as their spatial arrangements for a given area, floor area, or employment unit. The more diverse the urban form, the more indirectly beneficial it is for active travel and physical activity, because of the reduced distances between facilities (Sarkar et al., 2014, p. 95).
- Factor N3—Destination accessibility (accessibility to green spaces, retail and recreational facilities, as well as local food environments): A healthy neighbourhood should strive towards optimised clustering of health-promoting community services at the local level (Sarkar et al., 2014, p. 102).
- Factor N4—Street network morphology and connectivity: The street network influences street level accessibility and shapes individual travel behaviour and physical activity. Dense urban grids comprising highly interconnected straight streets crisscrossing and at right angles are manifestations of archetypal highly connected networks.
- Factor N5—Access to public transit stops and stations and active transport: The use of public transportation options reduces reliance on private vehicles and has been associated with enhanced levels of physical activity, in the form of exercise through walking and subsequent health benefits.
- Factor N6—Pedestrian-oriented design: Several studies on physical activity have introduced measures of the pedestrian infrastructure and degree of road safety. Neighbourhoods with pedestrian-friendly design promote activity with potential benefits to physical and mental health.

In research on the availability of green areas, their proximity is an important indicator. When investigat-

ing the role of green in housing areas, Alexander et al. (1977) indicates that for a park to fulfil the intended recreational functions, its area should not be less than 0.55 ha. The availability of green spaces is expressed in terms of the distance people want to travel to them. Gajda (2015), using the method of pedestrian access isochrones, observes that the green area should be easily accessible on a daily basis, within 500 m from the place of residence. The several-minute time frame for reaching a park has been confirmed by Alexander et al. (1977), among others. Based on his research, Alexander et al. (1977, pp. 308–309) recommend to:

Build one open public green within three minutes' walk – about 750 feet-of every house and workplace. This means that the greens need to be uniformly scattered at the 1500-foot intervals, throughout the city. Make the greens at least 150 feet across, and at least 60,000 square feet in area.

The methodology for the current study is based on the literature presented above.

### 3. Methodology: Quantitative and Qualitative Features of the Urban Environment Affecting Urban Health

In the present study, we started by defining a typology of built structures in the analysed neighbourhoods. This typology looks at the delimitation of morphological regions (Oliveira, 2016) characterised by specific parc, forms of architecture, and land use. Next, to define the method for the analysis in terms of ensuring health in the urban environment, we analysed the spatial determinants of health proposed by Sarkar et al. (2014, pp. 84–124) and other authors discussed above (Alexander et al., 1977; Forsyth et al., 2017). We overlapped these factors with the characteristics of modernist housing estates. Based on this analysis, we defined a collection of elements to examine more closely. Addressing the typology of open spaces, we distinguished three main classes:

1. Parking spaces with isolating greenery;
2. Recreational spaces;
3. Traditional urban streets.

In order to provide further categorisation, we overlapped these initial classes with the forms of open green spaces developed by Forsyth et al. (2017). We used the classification defined in Table 1 to understand and evaluate the forms of urban greenery present in the analysed case studies. However, the evaluation presented in the table is broader than the range of forms we can find in the analysed estates. We looked at the central angle values and dimensions of spaces between buildings, using the method for evaluation of outdoor spaces and enclosures defined in a classic Polish study by Wejchert (1984). We do not show the exact quantitative results here, but

they helped us to classify spatial types. We examined the activities taking place in the spaces following the above-defined typology. We looked at the relationships between forms of spaces and their usage, examined the behaviours of people using outdoor spaces, and assessed the availability of spaces for pedestrians. The results of these analyses are presented in a descriptive way.

The origins of the analysed structures can be found in the normative that functioned in Poland at the time when they were built (Skibniewska et al., 1979), as discussed in the previous section. To examine the densities (Factor N1; Sarkar et al., 2014,), we complemented the quantitative assessment by giving the values for the floor area ratio (FAR), building coverage ratio (BCR), and green area ratio (GAR) for spaces of the assessed estates. The GAR parameter was calculated based on a simplified equation dividing the green areas by the total size of the area. We also looked at distances to parks greater than 0.55 ha and at distances to bus/tram stops. In both cases, we verified the largest distance to the entrance of the farthest building. All the above observations provided the basis for transforming the outdoor facilities.

When preparing the graphical analyses, we used ArcGIS 10.3 for the Lodz case study and QuantumGIS for the Gdansk case study. The software and data availability affected the final form of the graphical analyses. Some discrepancies in the presented graphics might also stem from the usage of different data sets. In the case of the Lodz case study, we used data on the property structure, buildings, and land coverage from datasets provided by the Municipal Survey and Cartographic Documentation Centre in Lodz. In the case of the Gdansk housing estate, we used data provided by the Geodesy Department of Gdansk City Hall. Spatial data covering the network of park paths and pedestrian roads were downloaded from the OpenStreetMap website.

#### 4. Case Studies: Housing Estates in Lodz and Gdansk

Large housing estates from the modernist era are an essential part of the structure of Polish cities. The selection of the housing estates in Gdansk and Lodz was based on the fact that they are similar in terms of size and urban structure (typology of buildings and open spaces). Modernist housing is the dominant type of structure in both estates, and they are both representative fragments of a larger and more complex district. Based on the analysis of the typology of the built structures, we distinguish various forms of modernist blocks. In addition, in the Lodz housing estate, we notice the presence of several remnants of traditional structures: historic 19th-century buildings which were left behind from the pre-war period. After defining the boundaries of the areas, we analysed selected case studies looking at the conditions identified as pertaining to urban health. All the observations and photographs were taken in May 2022. We repeated the observations five times for each of the housing estates, on both weekdays and week-

ends, in the morning and in the afternoon. The results generalise the collected observations.

##### 4.1. Case Study in Lodz: Zgierska-Stefana Housing Estate in Bałuty

The post-war transformation of the Bałuty district in Lodz started immediately after the Second World War, in the period of socio-realism. The district, which initially developed as a suburb of Lodz, accommodated mostly poor inhabitants in quickly built, low-quality houses, with no sewage or water systems. The imposition of the Litzmannstadt Ghetto, which Nazi occupiers established during the Second World War, further contributed to the depletion of the local development. For these reasons, the communist government wanted to reuse the territory of Bałuty and create a new socialist district. The initial concept was created in the Warsaw Office of Workers Settlements (Zakład Osiedli Robotniczych) with Ryszard Karłowicz as the main designer. The whole territory was initially divided into six estates (Ciarkowski, 2018, p. 142). These initial units of the development followed socio-realistic rules, with buildings adjusted to the earlier street network. This was not the end of the redevelopment of the district. Further estates using modernist principles and prefabricated large-scale concrete building structures were erected until the end of the transformation period, and some development continues to the present day.

The housing estate Zgierska-Stefana (Figure 1) was designed in 1971–1972, and construction started in 1973. It was one of two large-scale housing estates built in the area at this time (Krystkowski, 2019). The building work lasted for over a decade. The design team representing Inwestprojekt included Leszek Paperz, Ryszard Daczkowski, and Andrzej Bohdanowicz. The prefabricated reinforced concrete systems Dąbrowa 70 and W-70 were used. The initial number of residents planned was close to 9,000 (“Osiedle Zgierska-Stefana,” 1971).

The Zgierska-Stefana estate is served by three arterial roads: Zgierska, Julianowska, and Łagiewnicka. On Zgierska and Łagiewnicka, there are tramway lines providing efficient communication to the centre of Lodz. Numerous buses travel along all three streets. The typology of buildings directly stems from the site’s history. Located in previously urbanised areas and built during a housing shortage, the blocks of flats with adjusting open spaces were located on available land between the already existing streets. The specificity of the local development led to the fragmentation of the urban structure. The site features both traditional, historical parcelations of the pre-war Bałuty and modernist organisation of space, with blocks of flats freely distributed in open space. Figure 1 and Figure 2 show the distribution of historical structures and modernist residential buildings. There are two main types: 11–12 storey buildings in a wave form isolating the development from surrounding arterial roads, and lower 4–5 storey structures located

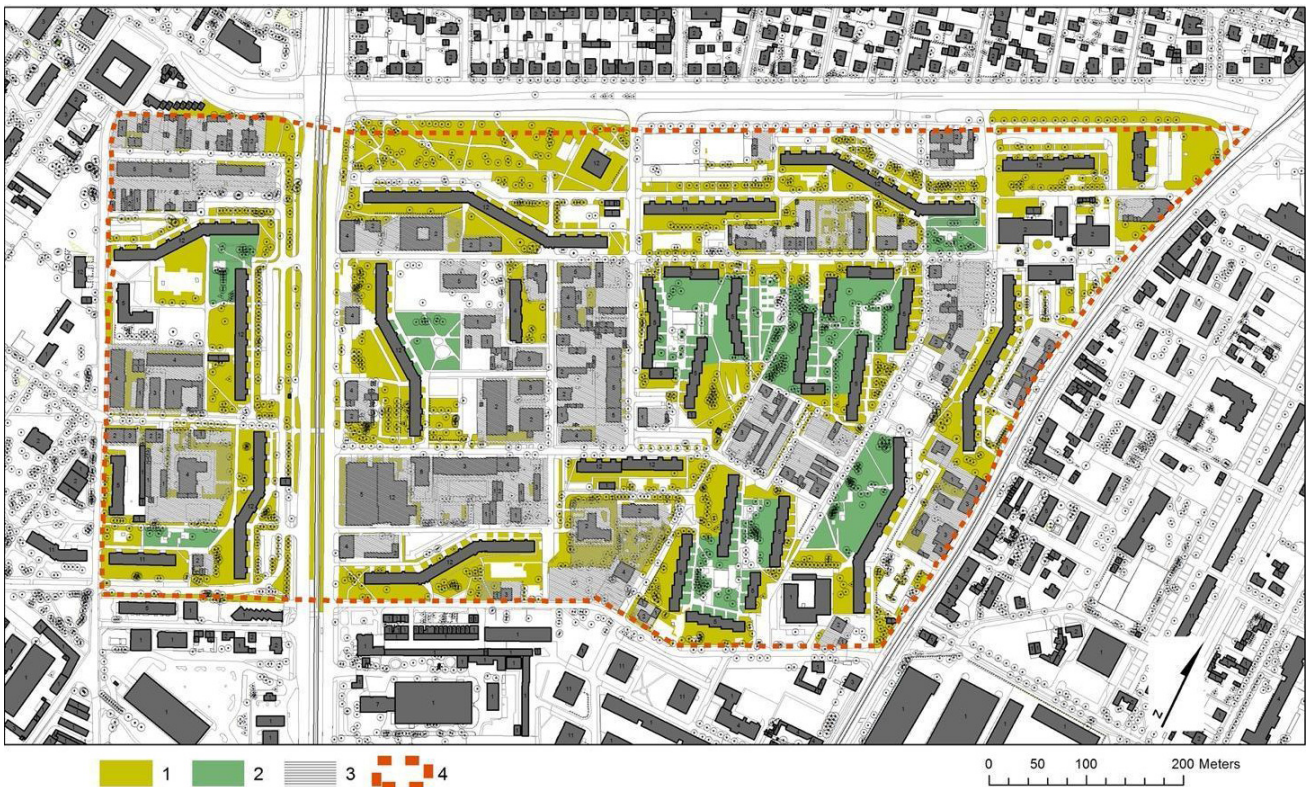


**Figure 1.** Typology of built structures of the Zgierska-Stefana estate, Bałuty, Lodz. Notes: (1) Twelve-floor wave blocks; (2) four- or-five-floor blocks of flats; (3) tower buildings; (4) auxiliary structures; (5) services, (6) buildings in the historical parts; (7) site limits; (8) historical development; A1–A12 are unit IDs.

inside. The configuration of historical streets strongly affected the layout of the buildings. Figure 1 also shows the units of development used in the quantitative analysis that follows. Figure 2 shows the analysis of open green spaces.

#### 4.2. Case Study in Gdansk: Fragment of the Przymorze Wielkie Housing Estate

In the 1960s and 1970s, many areas located on the outskirts of Polish cities experienced intense urbanisation.



**Figure 2.** General layout of the Zgierska-Stefana housing estate with an analysis of the types of open green spaces. Notes: (1) Greenery isolating and accompanying buildings; (2) recreational spaces; (3) historical parcellation; (4) site delimitation.

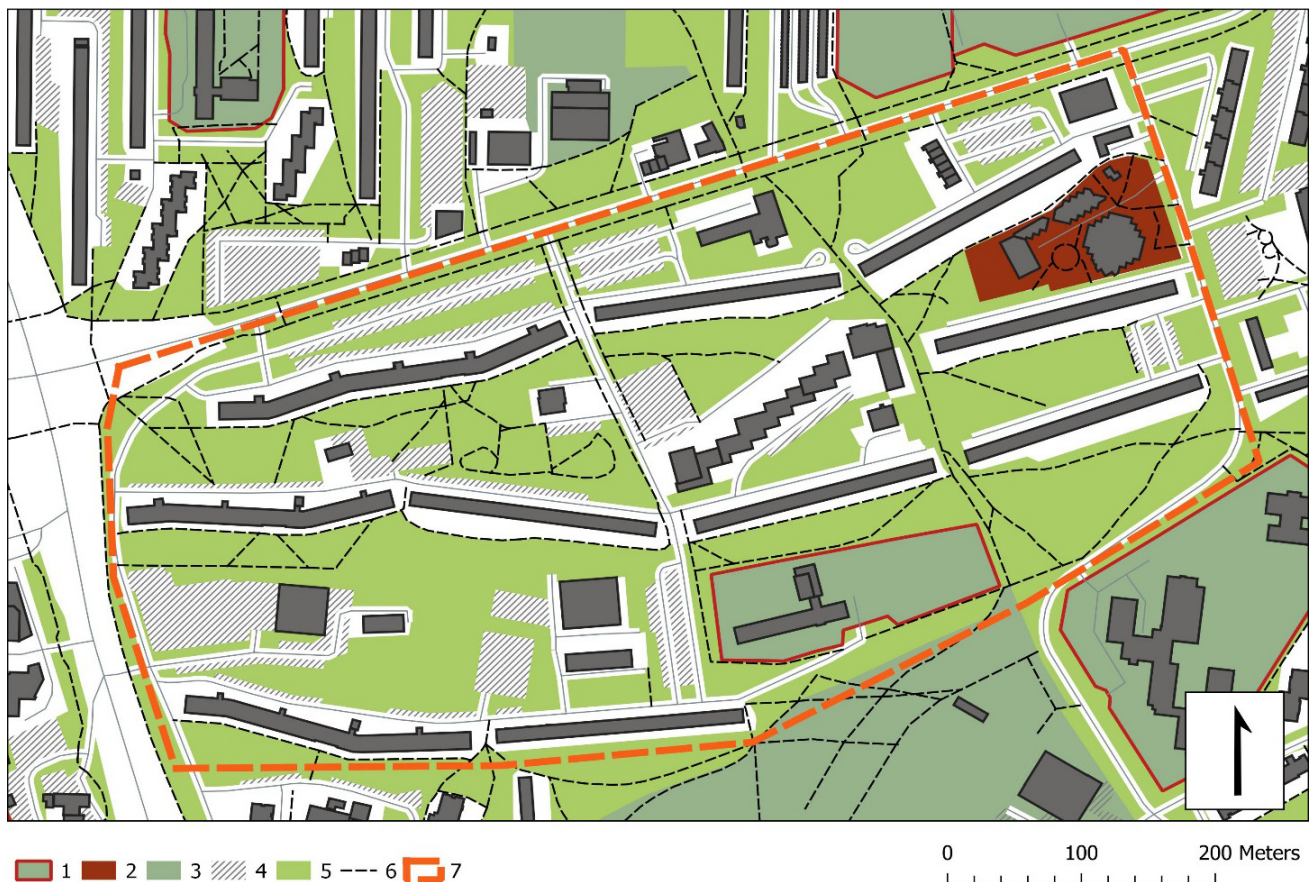
Today, there is “an investment renaissance” in the modernist districts of Przymorze, Zaspą, Żabianka, and Morena (Rembarz, 2009). The Przymorze estate in Gdansk is 200 ha large and was designed for 50,000 inhabitants. In 1959, the SARP (Polish Republic Architects’ Association) competition was held for the estate and the chosen design was created by Tadeusz Poznański, Józef Chmiel, Tadeusz Różański, Janusz Morek, and Danuta Olędzka. The final urban design of the estate was developed by Józef Chmiel and Tadeusz Różański.

The housing estate is divided into two parts: Przymorze Małe and Przymorze Wielkie. In Przymorze Małe, the development is dominated by low and medium-sized blocks of flats, with some single-family houses. Przymorze Wielkie consists of blocks of flats and Ronald Reagan’s Park. The longest building in Poland, the so-called “wave building” (860 m long), is located on Obrońców Wyrbeża street. The whole district is called Przymorze.

The analysed area (limited by Rzeczpospolitej street, Kołobrzaska street, and Olsztyńska street) is characterised by diversified developments, mainly with a multi-family residential or service function. The housing development can be divided into 11-storey high gallery buildings (the so-called “wave buildings”) and five-storey high multi-family sectional housing. There are also vari-

ous services in the area: retail, religious, and educational. A characteristic element of the analysed area is the presence of green areas of various functions and forms: isolation and buffer greenery, recreational greenery, greenery accompanying multi-family housing (so-called “home gardens”), playgrounds, as well as sport and recreational areas. In addition, there is poorly maintained greenery in the area: large spaces of low greenery (e.g., lawns, in poor condition). Greenery is also an important compositional and functional element of the district. Green areas in Gdansk are valuable elements of green infrastructure. The analysed area has close access to a park (more than 0.6 ha in size) on the north side of the plot, a one-minute walk from the northern border. However, 24 out of Gdansk’s 34 districts do not have a park of more than 0.6 ha in size within their borders (Korwel-Lejkowska & Topa, 2017).

Despite the fact that the analysed area is relatively rich in green areas (Figure 3), it is also filled with neglected green spaces, which lack a clear function (recreational, sports, or other). These areas are of different sizes, but, usually, they are relatively large in relation to the whole area. The analysed neighbourhood is very well connected by public transport. Bus and tram lines and the use of public transportation options reduce reliance on private vehicles. Destination accessibility (accessibility



**Figure 3.** Analysed area of the Przymorze Wielkie housing estate in Gdansk with a schematic representation of green areas. Notes: (1) greenery isolating and accompanying buildings; (2) retail and recreational spaces; (3) fenced public facilities with greenery, (4) parking places; (5) greenery; (6) paths; (7) site delimitation.



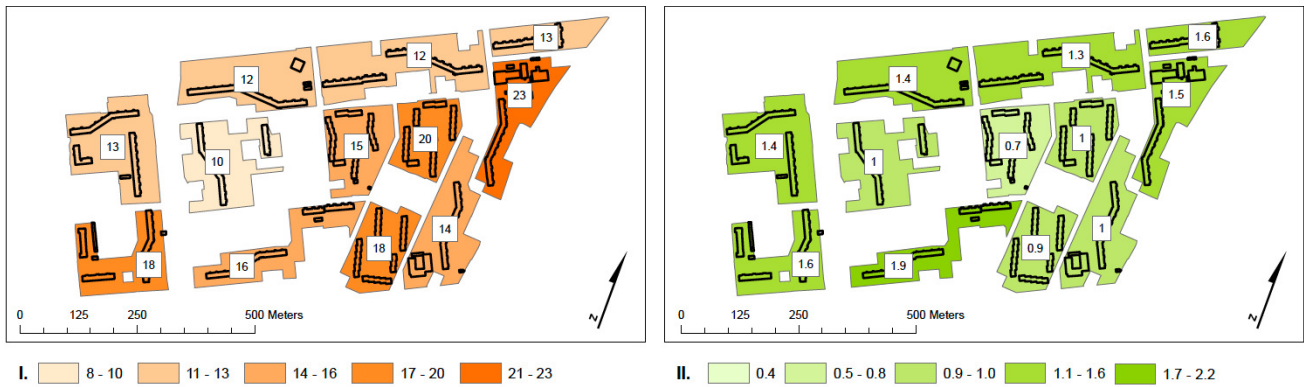
to green spaces, retail, recreational facilities, and local food environments) is very good and encourages walking rather than driving.

### 5. Results and Discussion

In this section, we present the results of the analysis using the methodology defined in Section 3. We start from calculations of the FAR and BCR followed by analysis of the GAR. In the case of the Lodz site, we performed the calculations in sections (Figure 1 and Figure 4), which made it possible to differentiate between modernist and earlier traditional developments. In the case of the Przymorze estate, due to its homogeneity, we calculated values for the whole site and examined it as one entity. Because of this difference in approach, we excluded streets as a separate entity in the analysis of the Zgierska-Stefana estate in Lodz.

The results of the analysis of FAR, BCR, and GAR for the Zgierska-Stefana estate in Bałuty, Lodz, are presented in Table 2 and Figure 4. They show moderate values (from 0.7 to 1.9), which are typical for urban areas. In the case of the modernist development, the FAR results are accompanied by relatively low values for BCR, ranging from 12% to 23%. Whereas FAR is at similar levels for the traditional development, the BCR values are much higher (32.5%). The share of open green spaces reflects this. In the case of modernist development, the share of open green spaces ranges from 26% to 60%, whereas in the case of the historical development, the share is as low as 10%. In the studied area of Gdansk, the FAR is 0.5, BCR is 13%, and the GAR is relatively high at 38%.

A comparison of the two estates in Lodz and Gdansk shows that the one located in the historical district features higher overall BCR values, with relatively similar FAR values. The share of green spaces is higher for the



**Figure 4.** Results of analysis of (I) BCR and (II) FAR.

**Table 2.** Results of calculations of FAR, BCR, and GAR for both estates.

Zgierska-Stefana Estate in Bałuty, Lodz				
Field ID	Total area (m <sup>2</sup> )	FAR	BCR	GAR
Streets	77,718	0	0	20
Historical development	117,067	0.9	32.5	10
A1	13,561	1.6	13	47
A2	23,710	1.5	23	26
A3	27,319	1	14	33
A4	34,836	1.3	12	36
A5	19,557	1	20	60
A6	20,049	0.9	18	54
A7	22,915	0.7	15	52
A8	30,258	1.4	12	55
A9	27,565	1	10	41
A10	21,314	1.9	16	44
A11	32,028	1.4	13	36
A12	22,448	1.6	18	43
Przymorze Wielkie in Gdańsk				
Field	Total area (m <sup>2</sup> )	FAR	BCR	GAR
Area (including streets, buildings, and open spaces)	272,942	0.5	13	38

estate built on a greenfield site. These observations are consistent with those reported by Berghauser Pont and Haupt (2009). Whereas in both housing estates the green spaces contribute to the system, fulfilling the requirement defined by Forsyth et al. (2017) and Harnick (2006), the fragmentation of the Zgierska-Stefana estate in Lodz lessens the availability of a diverse recreational offer. On the other hand, in the case of the Przymorze Wielkie estate in Gdansk, the recreational options are limited by the spatial configuration and lack of sufficient equipment. A detailed analysis of the forms of green spaces

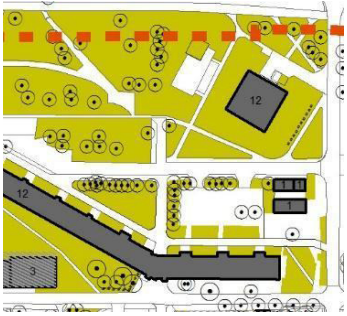




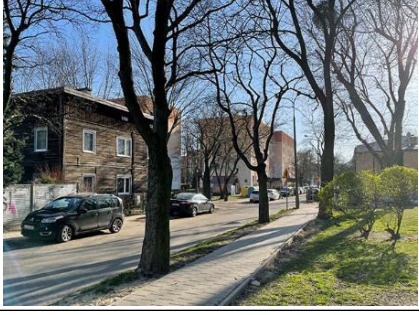
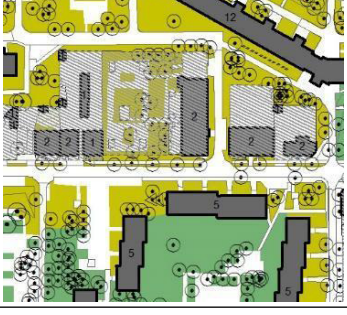


and the activities available is provided in Table 3 and Figures 2 and 4.

In the case of the Zgierska-Stefana housing estate in Lodz, we distinguish the following types of open green spaces: recreational spaces with playgrounds; spaces of isolation and neighbouring greenery; and streets, usually historical, with rows of trees (Table 3). There is also a larger green area nearby (Table 4), which fulfils the condition defined by Alexander et al. (1977). The first type of open green space (recreational space with a playground) is usually located in the central part of the estate,



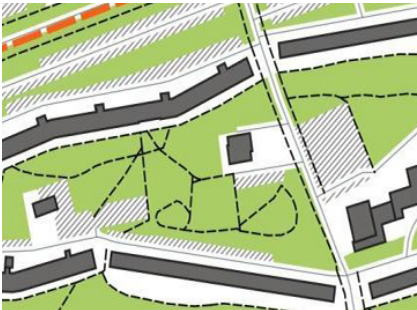







**Table 3.** Forms of open spaces.

Zgierska-Stefana Estate in Bałuty, Lodz		
Type of open space	Plan	Photographs
Recreation: Playground and open space		
Recreation: Playground and open space		
Recreation: Playground and open space		
Isolation and parking		



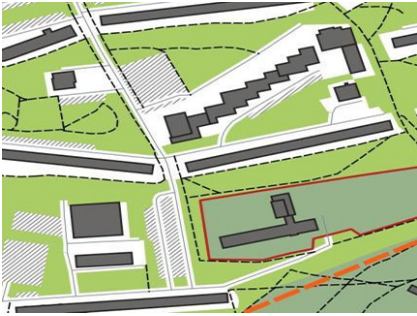

**Table 3.** (Cont.) Forms of open spaces.

Zgierska-Stefana Estate in Bałuty, Lodz		
Type of open space	Plan	Photographs
Isolation and parking		
Isolation and parking		
Historical streets		
Historical streets		
Przymorze Wielkie in Gdańsk		
Type of open space	Plant	Photographs
Recreation: Playgrounds		

**Table 3.** (Cont.) Forms of open spaces.

Przymorze Wielkie in Gdańsk		
Type of open space	Plant	Photographs
Recreation: Private gardens in multi-family housing		
Open spaces as semi-public spaces		
Open spaces as semi-public spaces		
Isolation and parking		
Parking and semi-green isolation spaces		

**Table 3.** (Cont.) Forms of open spaces.

Przymorze Wielkie in Gdańsk		
Type of open space	Plant	Photographs
Streets and pedestrian roads		
Streets and pedestrian roads		

isolated from traffic by surrounding blocks. Green spaces located more in the outskirts due to their parking function serve more for isolation from noise and pollution from surrounding streets. We noticed that people who use these spaces only rarely sit there or stop to spend time, contrary to how the more recreational sites in the centre are used. The recreational locations accommodate all age groups. Children and young adults often exercise there, and older people meet there to chat. The condition which is fulfilled in this case is linked to safety from traffic. Historical streets provide access and connectivity between other locations; they also offer a diverse range of services. Similarly to the rows of trees planted along many blocks, they provide pleasant views from windows and thus increase the psychological well-being of residents (Brown et al., 2013). Overall, we notice that while the provision of green open spaces in the modernist development is higher than elsewhere, its proximity to arterial roads and parking hinders the use of

the green spaces for recreation. Locations in the outskirts tend to be overwhelmed by parking for cars, which increases the danger of accidents. In all, greenery in the modernist development could provide more positive outcomes for health if the parking issues are solved. This is feasible since public transportation is well organised and available in direct proximity to all the buildings (Table 4).

In the case of the Przymorze Wielkie estate in Gdansk, the forms of available recreation are more diverse, including playgrounds, sport facilities, and private gardens (Table 3). There are also enclosed spaces with private gardens, sports facilities (school areas), and playgrounds (fenced and unfenced). The John Paul II Park is in very close proximity (within a minute from the northern border), while bus and tram stops are within walking distance and well-connected to the area (Table 4). Unfortunately, the majority of green spaces lack a clearly defined function. The activities that take place in these spaces are congruent with the observations of Lis (2011)

**Table 4.** Distances to the closest facilities: Park and stops for public transportation.

Facility	Distance of the closest block	Distance to the most remote block
Zgierska-Stefana Estate in Bałuty, Lodz		
Julianowski Park	482 m	About 1 km
Tram/bus stop	36 m	360 m
Przymorze Wielkie in Gdansk		
Park of John Paul II	Approximately 50 m	950 m
Tram stop	350 m	900 m
Bus stop	94 m	650 m

for the larger housing estates in Wrocław (for example, Polanka). However, due to the lack of specific context and necessary facilities, they are not used as frequently. Another feature of the space which diminishes its use for recreation is its vastness and a lack of a clear purpose. There are also extensive urban interiors, with many parking lots with or without green isolation. Diversity of functions is preserved, and we can define the area as a pedestrian-friendly environment (according to the factors defined by Sarkar et al., 2014).

## 6. Conclusions

In this study, we have compared two housing estates that fulfil many assumptions included in the CIAM Athens Charter, assessing their effectiveness in terms of residents' health. While similar in terms of the typology of buildings and scale, they differ significantly with regard to context. Following a methodology based on the current research on urban health, we looked first at the available green spaces, in terms of physical access, visual appearance, and system properties. Our primary focus was on recreational uses of green open spaces. We noticed that the scale, presence of necessary equipment, organisation of traffic and parking, and safety level affect the recreational potential of these spaces. Moreover, the placement of the Zgierska-Stefana estate in historical Bałuty in Łódź, without altering the previous development, has resulted in fragmentation of the space and, consequently, smaller sites for recreation and a reduced variety of available facilities and forms of greenery. Preserving the layout of historical streets enables cars to enter the estate, further reducing the availability of space for recreation. Green spaces located on the edges serve as isolation and complement the development. Nonetheless, the share of green space is higher than in the historic structures. Several studies have suggested that multi-unit dwellings and multi-storey housing have adverse implications on mental health (Sarkar et al., 2014). Green spaces have multiple benefits for promoting community health: providing pollution-free environments and providing spaces where individuals can relax with potentially positive effects on mental and physical health (Sarkar et al., 2014). The high values for GAR open up a whole range of psychological benefits and improve the well-being of residents. They also contribute to a range of ecosystem services, following the assessments given in Table 1 (Forsyth et al., 2017) and by Battisti et al. (2019).

Despite the high percentage of green areas in the analysed fragment of the Przymorze Wielkie estate in Gdansk, some of them are dedicated to a specific group of recipients (e.g., fenced playgrounds or school sports facilities), while others are large, poorly maintained green areas. Moreover, multi-family dwellings tend to be closer to busy streets and are exposed to higher levels of traffic and pollution, which also affect mental and physical health. However, accessibility to green spaces is high,

which can potentially have a positive impact on mental and physical health. It should be emphasised that it is not only the quantity but the quality of green areas that largely determine their use, and, more importantly, their impact on health.

An important conclusion from our research is that the study of urban forms and the quality of open, green public spaces in terms of their impact on health should be approached holistically and in a wider context. This means that not only the amount of public space but, most importantly, all its form and multiple functionalities should be taken into account when designing urban spaces. Neighbourhood-level determinants of health, such as density and intensity, diversity, destination accessibility, street and passage network morphology and connectivity, access to public transit stops, and pedestrian-oriented design should be taken into account in order to create a healthy city. Together, these physical and socio-economic characteristics of the neighbourhood combine to play a significant role in defining the health of residents (Sarkar et al., 2014).

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## Conflict of Interests

The authors declare no conflict of interests.

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