A Statistical Meta-Analysis of the Neighborhood Design Elements on Social Capital

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Abstract

Following the decline of social capital after the spread of urban sprawl, in the last two decades in various fields, including urban design and planning, growing empirical studies have been conducted to examine the relationship between "built environment" and "social capital. These studies have different and sometimes inconsistent and contradictory results, and researchers do not have comprehensive and sufficient information about the results of findings obtained from all researches. The purpose of this research is to classify aspects of the built environment related to social capital at the neighborhood scale and to find their effect size on social capital. to investigate the main purpose of the research based on meta-analysis method, keywords related to neighborhood design elements and social capital were searched in ISI Web of Science and Scopus databases from 2000 to 2019. After identifying and screening the articles, based on the inclusion and exclusion criteria, 33 articles were included in the meta-analysis. After extracting the statistical data of each article, social capital data were coded in two behavioral and cognitive dimensions and neighborhood design elements data were coded in building, density, land use, street and public space dimensions. After analyzing the results using CMA (V.2) software and checking the heterogeneity between the studies with the I2 test, the random model was used to extract the average effect size.Therefore, among the neighborhood design elements the street dimension (ES=0.306) and then the land use dimension (ES=0.120) have the highest impact on the behavioral dimension of social capital and the public space dimension (ES=0.2) has the most significant impact on the cognitive dimension of the social capital.

Keywords: Neighborhood design elements; Social capital, community participation; Sense of community; Meta-analysis

1. Introduction

Attention to social capital and its presence in academic literature has increased since late 1990s. Despite the various meanings, the definitions provided by prominent philosophers in this field such as Putnam, Coleman and Sander are more popular. Social capital is defined as trust, norms and networks that facilitate cooperation and optimal participation of community members and ultimately provide their mutual benefits (Putnam, 1994).

In addition to demographic factors such as age, gender, marital status, education level, income, religion and length of stay; social factors such as, history and culture of the society, social structures, social class, economic-social heterogeneity, level of security and Psychological factors such as, sense of place and place attachment, variables related the built environment also play a role in the formation, strengthening or weakening of the social capital. (Aldridge et al ,2002; Wood & Giles-Corti,2008). In the last decade, in various fields of sociology, urban design, environmental psychology, geography, and public health, growing experimental studies have been conducted in the field of examining the relationship between social capital and the built environment.

The increase of urban sprawl after the Second World War and the consequences such as the decrease of the social capital led researchers to investigate the impact of environmental factors such as suburbanization and urban sprawl on social capital. They claimed that one of the causes of social capital decrease in the last 30 years in the United States, is the increase of urban sprawl (Putnam ,2001). Urban designers also, from the early 1990s, through the New Urbanism principles (pedestrian-oriented and mixed-use developments) sought to improve social capital by increasing social interactions. Therefore, several studies in urban planning and public health have begun to analyze the relationship between a pedestrian-oriented environment and social capital.

Nevertheless, in recent experimental studies, contradictory findings have been reported that urban sprawl can strengthen various social capital. (Nguyen, 2010) and some researchers have questioned the effectiveness of New Urbanism principles (Hanibuchi, 2012; Jun&Hur, 2015).

The diversity of the results of numerous researches and even sometimes being uncoordinated and inconsistent, and on the other hand, the difference in the methodological characteristics of these studies, the extent of variables and measuring tools related to social capital and neighborhood design elements, make it difficult for researchers to compare the data of these studies. Hence, conducting meta-analysis research to provide a comprehensive and clear picture of the results of the findings obtained from all studies and to prevent repeated

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and inconclusive research seems necessary; Especially that the previous studies have often analyzed and reviewed the conducted studies as qualitative and systematic review (Wood & Giles-Corti,2008; Mazumdar,2018).

According to the mentioned cases, the main purpose of this research is to summarize the information, quantitative analysis of research articles and classification of aspects of the built environment at the neighborhood scale under the title "neighborhood design elements" that are related to social capital. This research aims to calculate the effect size of neighborhood design elements on the multiple dimensions of social capital by combining the results of the articles, so since the most effective elements on social capital at the neighborhood scale can be determined.

2. Method

In this article, the meta-analysis method is used as a statistical technique to determine, collect, combine and summarize research findings with the relationship between neighborhood design elements and social capital. The process of statistically combining the results of independent and separate studies to reach general results about the effect size is called meta-analysis. In other words, this technique summarizes previous research that uses the quantitative methods to compare outcomes across a wide range of studies. Meta-analysis is a set of statistical methods that is conducted to combine the results of independent experimental and correlational studies that have the same research questions about a single subject and leads to a single estimate and result. Unlike traditional research methods, meta-analysis uses statistical summaries of individual studies as research data (Borenstein et al., 2009; Hunter& Schmidt, 2004).

For this method, several steps are mentioned, that in this article, the six steps of Chung, Burns, and Kim (2006) are being used, which includes defining the research question, searching the literature, selecting research, extracting data, analyzing data, and reporting findings and results (Chung et al.,2006). An attempt has been made to use Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) in the various stages of this method.

2.1. Research question definition

In meta-analysis as scientific research, the starting point of the research is the problem statement, question design and research hypotheses. This article seeks to answer the following questions:

- What physical variables have been studied in the researches conducted in the field of the relationship between neighborhood design elements and social capital?
- What social variables have been studied in the researches conducted in the field of the

relationship between neighborhood design elements and social capital?

- What is the average effect size of neighborhood design elements being effective on social capital and the effect of which factor is more than the others?
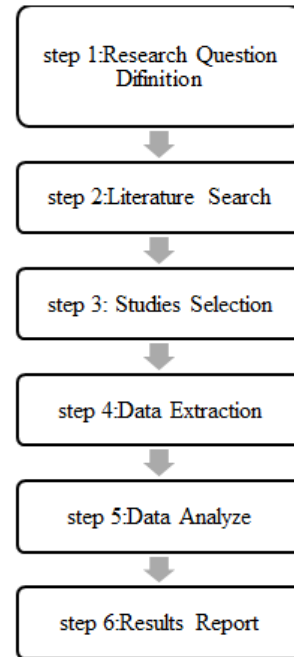

Fig. 1.Practical guide to Meta-analysis (Chung et al., 2006)

2.2. Literature search

To find the desired research, first, by using the following keywords, some articles were collected which had been published in English from 2000 to 2019 in ISI Web of Science and Scopus scientific databases and the list of sources of found articles was evaluated for the inclusion of other possible sources. A total of 3940 articles were found and after removing the duplicate records, 2000 articles were left:

neighborhood (neighborhood) design(OR)neighborhood planning(OR)neighborhood environment(OR) neighborhood feature(OR) neighborhood characteristics(OR) residence characteristics(OR) community planning feature & social capital (OR) sense of community (OR) social cohesion(OR) social sustainability(OR) community attachment (OR) social integration(OR) social interaction (OR) social ties(OR) social network(OR) Social Trust(OR) Sociability(OR) Social relationships(OR) neighboring behavior(OR) collective efficacy (OR) community participation(OR) community involvement(OR) volunteering (OR) collective action(OR) social support(OR) social inclusion (OR) social mix(OR) social equity(OR) Social justice.
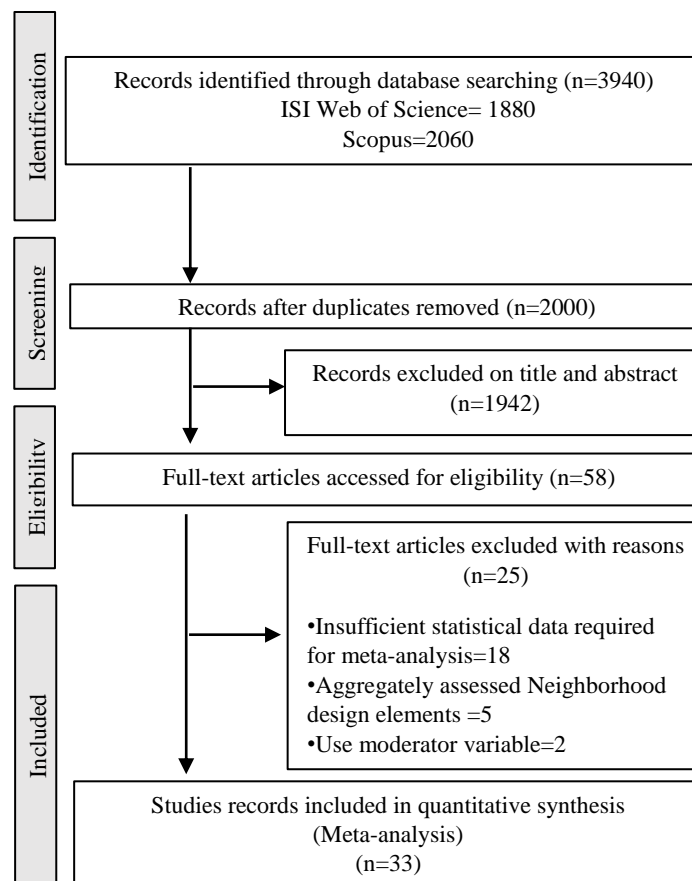
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Identification   Records identified through database searching (n=3940)
                 ISI Web of Science= 1880
                 Scopus=2060

Screening        Records after duplicates removed (n=2000)
                                        →  Records excluded on title and abstract
                                           (n=1942)

Eligibility      Full-text articles accessed for eligibility (n=58)
                                        →  Full-text articles excluded with reasons
                                           (n=25)

                                           •Insufficient statistical data required
                                           for meta-analysis=18
                                           •Aggregately assessed Neighborhood
                                           design elements =5
                                           •Use moderator variable=2

Included         Studies records included in quantitative synthesis
                 (Meta-analysis)
                 (n=33)
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Fig. 2. Studies selection process according to PRISMA guidelines

2.3. Studies selection

All the potential researches related to the research topic should be examined to make a decision as a result, it should be determined which research is included in the study and which one is excluded from the study process. Therefore, it is necessary to define the inclusion and exclusion criteria of resources at the beginning of the work:

2.3.1. Type of articles

Scientific-research articles published in English-language journals are included in this article, and descriptive and review articles and books are excluded.

2.3.2. Independent variable

In the analyzes conducted, articles that consider the physical components of the built environment as independent variables have been included, and articles that only investigated the impact of social components such as, the occurrence of crime and social problems in the neighborhood (Oidjarv, 2018), Demographic components like population density (Brueckner and Largey, 2008), second homes (Gallent, 2015) and traffic situation (French et al, 2013; Arundel&Ronald, 2017) on

social capital, were excluded from the scope of this article.

2.3.3. Dependent variable

In various studies, the social and psychological meanings related to the neighborhood are intertwined. In the conducted research, the relationship between neighborhood design elements and psychological concepts such as satisfaction (Vemuri et al., 2011), place attachment(Bonaiuto et al., 2003), mental well-being (Zhang & Zhang, 2017), vitality (Zumelzu & Barrientos-Trinanes, 2019), social concepts such as social capital (Hanibuchi, 2012), social interactions (Raman, 2010), sense of community(Jun & Hur, 2015), social cohesion (Cooper et al., 2014) and social sustainability (Hagen et al., 2017), health-related concepts including physical health (Ding & Gebel, 2012) and mental health (Walsh & LaJoe, 2018) and safety and security (Cowen et al., 2019) have been investigated. In this article, only the meanings that carry social concepts and related to social capital (as a dependent variable) have been investigated. Therefore, concepts related to psychology, health and safety are out of the scope of this article.

2.3.4. Scale

The scale beyond the neighborhood, such as the city and urban space, are not included in the scope of this article (Barton,2000) .On the other hand, scales smaller than the neighborhood, such as the scale of buildings, streets, residential complexes and gated communities, are not included in this article (Swapan et al.,2018).

After screening articles by reading the title and abstract of the articles and selecting relevant articles and removing irrelevant ones according to the above criteria, 58 articles were left for check eligibility.

2.3.5. Statistical data of articles

Researchers should have reported valid statistics which can be converted into the effect size, such as the standardized beta coefficient (β), odds ratio (OR), correlation coefficient, *t*-value and confidence interval (CI). According to this criterion, 18 Articles have been removed from the meta-analysis (Brown & cropper,2001; Pendola & Gen,2008 ;Wood et al.,2010 ;Podobnik ,2011; Cabrera& Najarian,2013; Schellenberg et al. 2018).

2.3.6.Aggregated data

Some articles Aggregately assessed Neighborhood design elements like sprawl index as the resultant element of density and street (Nguyen, 2010), The neighborhood environment as a consequence of land use and public space (Ross & Searle, 2019, Ozkan et al., 2019), Pedestrian oriented neighborhood (Zhu et al., 2014) and neighborhood design (Wood et al., 2012),have been investigated as the concept of land use and street elements, which are not included in the analysis of the upcoming study.

2.3.7. Other variable

 Some articles have examined safety and security as a moderator variable, which is therefore not within the scope of this article (Bjornstrom& Ralston, 2014, Hong et al., 2018).

After studying the full text of the screened articles and selecting related articles according to above criteria, 33 articles were left for data entry into the software and quantitative meta-analysis steps (Figure 2).

2.4. Data extraction

In the appraised articles, various domains of social capital and different components of built environment have been measured. The findings of the studies should be condensed into a common framework so that their comparison is possible. For this reason, according to the existing theories, these various domains were categorized and condensed into sub-domains and were placed in the meta-analysis matrix. Summarization of information in the form of publication dimension (year, author, journal) and methodology dimension (statistical method, sample size) and Condensation of independent variables and dependent variables into common sub-domains, have been done in this stage (Chung et al.,2006) (Appendix1).

At this stage, all statistically significant and non-significant data were considered in each article. Because the removal of non-significant data causes the average effect size to be biased and distance from the null hypothesis, putting the value of zero instead of non-significant data is biased towards the null hypothesis. Meta-analysis avoids relying on the significance test of any finding as a measure of its value and helps us to find that repeated results in a research path with multiple studies that Even if one of them is not significant, it is strong evidence for a significant result. Therefore, in meta-analysis, even small and insignificant effects can play a role in obtaining a general picture of the results of a research action (Rosenthal, 1995).

2.4.1. Neighborhood design elements

The characteristics of the built environment at the neighborhood scale in the urban design literature are mentioned under the titles of neighborhood design, physical environment, urban form, local community, neighborhood, urban environment, living environment, environmental design, environmental characteristics, and neighborhood characteristics.

The qualities of design elements are essential   in determining the characteristics of a neighborhood. The dominant elements mentioned in neighborhood design include elements such as density, land use, street layout, public realms (public buildings, squares or plazas) and open spaces (playgrounds and parks), natural features and landscaping. (Southworth & Owens, 1993; Cervero & Kockelman, 1997; Handy, 1996; Moudon et al., 1997; Thorleifsdottir, 2008).

In this article, according to the systematic review by the author, from the sharing of frequent dimensions of neighborhood design that are effective on social capital, five elements of density, building, land use, streets and public space have been considered as elements of neighborhood design.

In addition to the mentioned elements, in a number of articles, the result of the synergy of all elements of residential density, mixed use and street network under titles such as neighborhood design (Rogers & Sukolratanametee, 2009), new-urbanism neighborhood (Kim & Kaplan, 2004), transit-oriented development (TOD) (Kamruzzaman et al., 2014) and walkability (Du Toit et al, 2007; Hanibuchi, 2012) has been calculated and its relationship with social capital has been investigated. These concepts were also included in the meta-analysis process as a separate domain under neighborhood type.

Building: The review of the studies shows that housing type, building density, number of floors and aesthetic dimensions of the housing are among the factors influencing the formation of social capital in the neighborhood. Raman (2010) in his research in six UK neighborhoods concluded that higher building forms had a significant negative relationship with all types of perceived social contacts(Raman,2010). Dwelling area (Bottini, 2018; Arundel&Ronald, 2017), building density and housing type(Tsai, 2014; Lee et al., 2017;

Arundel&Ronald, 2017; Bottini, 2018) and building frontage length (Arundel&Ronald, 2017) are indicators that belong to the building domain in this article.

Natural surveillance (Dempsey, 2009), historical buildings (Arundel & Ronald, 2017) and attractive buildings (French et al., 2013) are also among other elements related to the building element, which were listed in the examined articles as positively related to social capital dimensions, but due to lack of repetition in other articles, they were excluded from the meta-analysis process.

Density: Density is a complex concept with interconnected dimensions. Population density and residential density units are the most common measures used in urban research. In the objective definition, the density is the number of people or the number of dwellings per area unit, while in the subjective evaluation, the density is a social interpretation that refers to individual characteristics and differs from the residents of one area to another. (Jenks & Jones, 2010). Residential density (Dempsey, 2009; French et al., 2013; Kamruzzaman et al., 2014), perceived density (Jun & Hur, 2015) and perceived privacy (Raman, 2010) are indicators that belong to the density domain.

Land use: The topic of diversity of land uses is used to show a mix of residential, commercial, sports and recreational uses, including the existence of green space. On the other hand ,in this framework, accessibility and proximity to a range of destinations including retail, sports, recreation, health clinics, hospitals and restaurants (travel destinations) belong to the land use domain.

Mixed-use (Leyden, 2003; Kamruzzaman et al., 2014; Yoo & Lee, 2016; Oidjarv, 2018), pedestrian access to land uses (Lund, 2003; Leyden, 2003; Cohen et al., 2008; Jun & Hur, 2015; Yoo & Lee, 2016; Arundel& Ronald, 2017, Oidjarv, 2018), access distance to land uses (Hipp et al., 2014; Tsai, 2014; Jabareen& Zilberman, 2017), satisfaction towards neighborhood facilities (Lim et al, 2017) and parks and green spaces (Lund, 2003; Cohen et al., 2008; Mason, 2010; Hipp et al., 2014; Yoo & Lee, 2016; Lee et al., 2017) are indicators that belong to the land use domain.

Street: The street layout describes the spatial arrangement and configuration of street, block and building elements and has an important impact on walkability and how different spaces and streets are connected to each other. Layout refers to the permeability and control of movement and pedestrian access and can affect other aspects of neighborhood design, such as density and land use. The configuration of the street network, the size of urban blocks, and their position in the urban structure can affect the location and intensity of activities and the vitality of urban spaces. (Jenks & Jones, 2010). Street layouts are often discussed and examined in articles in the form of cul-de-sac layout (suburban neighborhoods), grid layout (traditional or neotraditional neighborhoods), or a mix of both (Wood & Giles-Corti, 2008; Cooper et al., 2014)

The street network layout (Lund, 2002; Mason, 2010; Raman, 2010; Hopkins & Williamson, 2012), presence of sidewalks (Mason, 2010; Zhang et al., 2018), street network connectivity (Cooper et al., 2014), are indicators that belong to the street domain.

Public space: Public spaces as a fundamental element of the neighborhood environment play an important role in shaping community participation and may foster sense of community by facilitating chance encounters between neighbors (Talen, 2000; Zhu, 2015). Public space as a "third place" is defined as the meeting or gathering places that exist outside the home and workplace that are generally accessible by members of the public, which foster resident interaction and opportunities for contact and proximity (Oldenburg, 1989).In this study, public space includes plazas, sidewalks, shopping malls, community centers and public transportation stations.

Number of public spaces and appraisal of their physical characteristics (Zhu, 2015, Oidjarv, 2018), maintenance (Dempsey, 2009; Yoo&Lee, 2016), cleanliness (Lee et al., 2017), components of public spaces such as pedestrian infrastructure, traffic calming devices, lighting, furniture and graffiti (Wilkerson et al.; 2012; French et al., 2013; Jun&Hur, 2015; Jabareen& Zilberman, 2017; Zhang et al., 2018), tree density (Holtan, 2015; Arundel& Ronald,2017), distance to the nearest public space (Francis et al, 2012) and access to public transportation (Dempsey, 2009; Kamruzzaman et al., 2014; Jabareen & Zilberman, 2017) are indicators that belong to the public space domain in this article.

2.4.2. Social capital

In this research, using the framework provided by Perkins and Long (2002), various terms used to describe the dimensions of social capital in 33 articles were coded in two cognitive and behavioral dimensions. This framework is based on the emphasis of Putnam (2001) and Saugert and Winkel (1998) on behavioral definitions of social capital.

In this theory, social capital is defined in four distinct components: (1) trust in one's neighbors (sense of community) (2) trust in the efficacy of organized collective actions (empowerment), (3) informal neighboring behavior, and (4) formal participation in community organizations .Sense of community and collective efficacy are under the cognitive components of social capital and citizen participation and neighboring are the behavioral components of social capital. (Saegert & Winkel, 1998; Putnam, 2001; Perkins & Long, 2002).

	Cognition/trust	Social behavior
Informal	Sense of community	Neighboring
Formally organized	Collective efficacy	Citizen participation

Fig. 3..Four dimensions of social capital (Perkins & Longs, 2002)

Sense of community: Concepts related to the sense of community as a catalyst for both behavioral dimensions of social capital including neighboring (informal) and organized participation (formal) were categorized under the cognitive dimension of social capital. The sense of community is often defined as the sense of affiliation of the members of a group; The feeling that group members care about each other and the group; A shared belief that the needs of members are met by being together (McMillan& Chavis,1986).

The relationship between the sense of community and organized participation is found in analyzing both individual and community dimensions. Residents who are interested in organizing an association and working collectively to solve problems must have some sense of community. Chavis and Wandersman (1990) found that over time, the sense of community will lead to self-efficacy, collective efficacy and neighboring, which all of these will increase participation (Lund,2002;du Toit et al.,2007; Dempsey,2009;Francis et al.,2012,French et al.;2013,Tsai,2014;Jun & Hur , 2015;Jabareen & Zilberman ,2017;Arundel& Ronald,2017).

Collective efficacy: Concepts related to collective efficacy or trust in the effectiveness of organized community actions as the closest concept to empowerment were categorized under the cognitive dimension of social capital (Cohen et al.,2008). In a number of articles, the concept of trust has been mentioned, which this concept is also categorized under the cognitive dimension of social capital (Leyden,2003; Dempsey,2009; Mason,2010; Johnson,2010; Kamruzzaman et al.,2014; Lim et al.,2017). Knowing Neighbors (Leyden, 2003) and perceived social network (Raman, 2010) are other concepts mentioned in the reviewed articles, which were placed under the cognitive dimension of social capital. According to the variables presented in the articles and referring to the concept of mutual trust, the concept of social cohesion (Hipp et al, 2014; Cooper, 2014) is placed in the cognitive dimension of social capital.

Neighboring: Concepts related to neighboring behavior or informal mutual assistance and information sharing among neighbors (Perkins & Long, 2002) were categorized under the behavioral dimension of social capital in this article. Connectedness with neighbors (Kamruzzaman et al., 2014), supportive act of neighboring (Lund, 2003; Rogers & Sukolratanametee, 2009; Oidjarv, 2018), neighboring behaviors (Hipp et al., 2014), neighboring (Wilkerson et al.; 2012), social interactions (Dempsey, 2009), meeting friends (Hanibuchi, 2012) and social network, the number of formal and informal social contacts and strength of them (Raman, 2010) are among the concepts mentioned in the reviewed articles.

Participation: Concepts related to participation as optional and voluntary involvement of the local population in the social and political affairs of the neighborhood (Zhu, 2015) were categorized under the behavioral dimension of social capital. Social participation (Leyden, 2003; Johnson, 2010), political participation (Leyden, 2003; Hopkins & Williamson, 2012), civic participation (Johnson, 2010), organizational active involvement (Theall et al., 2009), community participation (Zhu, 2015; Bottini, 2018; Zhang et al., 2018) are among the concepts that have been mentioned in the reviewed articles.

In the study of Hanibuchi (2012), mutual norms were placed as one of the components of social capital under the cognitive dimension and the component of membership in horizontal and vertical organizations under the behavioral dimension of social capital. The concept of social capital has been examined in the articles of Holtan et al. (2015), Yu and Lee (2016), Wood et al. (2008) under both cognitive and behavioral dimensions.

2.5. Data analyze

At this stage, the meta-analysis statistical operation was performed in the second version of the Comprehensive Meta-Analysis software (CMA2) and the average effect size of each of the neighborhood design elements affecting social capital was calculated in cognitive and behavioral dimensions. In this research, the average effect size across studies was estimated with a standardized beta coefficient (β) or correlation coefficient or odds ratio (OR) or t-statistic value.

After entering the data into the software, the average effect size of the variables was calculated in two fixed and random models. In the fixed effects model, it is assumed that the correct effect of the experimental action is the same in all studies, while the random effects model assumes that the estimation of the correct effect of the experimental action in each research is different from the other (Borenstein et al., 2009). Using CMA2 software, the coefficient of Heterogeneity between studies was checked with the I squared (I2) test . According to the result and the confirmation of the heterogeneity of the studies, the random model was used to extract the average effect size.

2.6. Results

An overview of the articles shows that the articles included in the meta-analysis have been published in 23 different journals: four articles in the Environment and Behavior journal, three articles in the Health & Place journal, three articles in the Cities journal, three articles in the Sustainability journal, and two articles in The Journal of Planning Education and Research has been published. The rest of the articles have been presented in 18 different journals. A total of studies have been conducted in twelve different countries: 13 studies in America, 6 studies in Australia, 3 studies in England, 2 studies in Taiwan, 2 studies in South Korea and 1 study in each of the countries of Ireland, The Netherlands, Italy, China, Japan, Malaysia and Israel (Table No. 2).

Collection of neighborhood design data in 13 studies was a combination of subjective and objective methods, 8 studies were only subjective and 12 studies were only objective. They were considering only the data of the density dimension in all studies have been measured objectively by using GIS and statistical data.

The collection of social capital data in all 33 studies has been done in a subjective way, and this measurement has been done by means of various tools through different concepts: 10 cases of community participation, 9 cases of sense of community, 9 cases of social interactions, 7 cases of trust, 5 cases of neighboring, 3 cases of social capital, 2 cases of social cohesion and one case of collective efficacy (Table No. 2).

For statistical data analysis, linear regression has been used in 27 cases: nine cases of hierarchical or multilevel regression, five cases of multiple linear regression, four cases of the generalized linear model (GLM), three cases

of multivariate linear regression, three cases of structural equation model (SEM) which is a type of multivariate Regression, two cases of stepwise regression and one case of simple linear regression have been used. The rest of the analysis included four cases of logistic regression, one case of variance analysis and one case of correlation (Table No. 2).

According to Table No. 1, the highest frequency of data belongs to the land use dimension data with 47 data among the behavioral dimension studies and 42 data among the cognitive dimension of social capital studies. The highest average effect size also belongs to street indicators in the behavioral dimension with an effect size of 0.306 and then public space with an effect size of 0.2 in the cognitive dimension. In the following, the results of the statistical test will be explained in more detail:
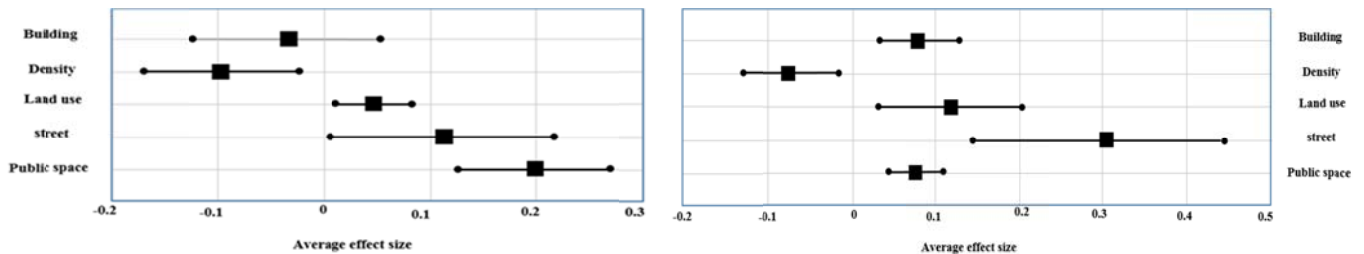

Fig. 4. Graph of Average effect size of neighborhood design elements with respect to cognitive (left) and behavioral (right) dimensions of social capital

Table 1

Average effect size (ES) of neighborhood design elements with respect to social capital dimensions

Neighborhood design elements		Social capital /cognitive dimension					p-Value	Social capital /behavioral dimension					p-Value
		Number of relationships			ES Random model	95%CI			Number of relationships			ES Random model	95%CI		
		Non sig.	+	-		Upper limit	Lower limit		Non sig.	+	-		Upper limit	Lower limit	
1	Building	8			-0.035	0.054	-0.123	0.443	9			0.082	0.131	0.034	0.001
		4	1	3					7	2	-				
2	Density	6			-0.097	-0.022	-0.17	0.011	6			-0.071	-0.013	-0.129	0.017
		2	-	4					3	-	3				
3	Land use	42			0.047	0.083	0.011	0.011	47			0.120	0.207	0.032	0.008
		20	15	7					20	22	5				
4	Street	11			0.114	0.218	0.007	0.037	14			**0.306**	0.449	0.148	0.000
		6	5	-					4	9	1				
5	Public space	20			**0.2**	0.271	0.126	0.000	23			0.077	0.110	0.045	0.000
		6	13	1					9	10	4				
	Neighborhood type	9			0.076	0.183	-0.032	0.168	9			0.079	0.144	0.013	0.018
		4	4	1					4	4	1				

2.6.1. Building

Among eight cases that researched the effects of building element of neighborhood, 12% (Tsai, 2014) have reported positive, 38% negative (Arundel&Ronald, 2017; Lee et al.; 2017, Bottini, 2018) and the remaining 50% non significant impacts on the cognitive dimension of social capital. The average effect size reported is -0.035; which is not statistically significant at the 5% level. Among nine cases that researched the effects of building element, 22% of cases (Lee et al.; 2017) have reported positive and 78% non-significant impacts on behavioral dimension of social capital and the average effect size reported is 0.082 (Table No. 1).

The result of Bottini's study in Milan, Italy has shown the importance of the building size as much as the place attachment (emotional bond) on community participation but in the opposite direction: with the increase of a unit of dimension of the neighborhood buildings, the attitude for participation decreases by 0.44 units and the effect of other physical dimensions is considered almost unimportant (Bottini, 2018). On the other hand; Lee et al (2017) have also concluded that living in higher-density apartments has decreased social trust despite increasing social participation and social network.

This is while the result of the research conducted among 19 neighborhoods in Taipei, Taiwan, indicates that with the increase in the percentage of houses with more than five floors, sense of community has also increased, this indicator is second in importance after the average travel distance index (Tsai, 2014). Another study conducted in Amsterdam, Netherlands, also shows that the housing area the above 150 square meters, although it increases the residents satisfaction, but it has a negative effect on the sense of community, and on the contrary, increasing the average length of the buildings increases the sense of community (Arundel&Ronald, 2017).

2.6.2. Density

Among six cases regarding the effects of density on cognitive dimension of social capital, about 67% of cases (Raman, 2010; French et al., 2013; Kamruzzaman et al., 2014; Jun&Hur, 2015) have reported a negative and no significant positive relationship, And the average effect size reported was -0.097. In the relationship between the effects of density on the behavioral dimension of social capital, 50 percent of cases (Dempsey, 2009; Raman, 2010; Kamruzzaman et al., 2014) have reported a negative relationship without any significant positive relationship, and the average effect size reported is -0/071 (Table No. 1).

In UK neighborhoods was found that the socializing patterns and structure of social networks are different in neighborhoods with high and low density. Neighborhoods with low density (perception of higher privacy) have wider social networks and activities with very few strong relationships. On the other hand, in high-Density neighborhoods have smaller but stronger social networks (Raman,2010).

According to the report of French et al, with the increase of residential density, sense of community has decreased (French et al., 2013). The study of Jun and Hur (2015), in line with other studies that pointed out the negative impact of density, it has also shown that people who perceive higher density have a lower sense of community (Jun & Hur, 2015).similarly, Kamruzzaman et al (2014) in three types of neighborhoods in Brisbane, Australia, have shown that net residential density independently as one of the environmental indicators have a negative impact on reciprocity and connections with neighbors.The results of these studies, contrary to the ideology of New Urbanists, do not confirm the positive effect of density on the sense of community.

Meanwhile, the study of Arundel and Ronald (2017) in Amsterdam, Netherlands, has shown that higher densities have no statistically significant effect on social capital and other measures such as scale and presence of local stores, the degree of car dominance and the construction period are more important.

2.6.3. Land use

From forty-twocases examined the effects of neighborhood land use on cognitive dimension of social capital, 36% of cases have reported a positive and about 17% (Wood et al., 2008; Theal et al., 2009; Kamruzzaman et al., 2014; Hipp et al, 2014 Lund, 2002;) a negative relationship and the average effect size was calculated 0.047. from forty- seven cases examined the effects of neighborhood land use on the behavioral dimension of social capital, about 47 percent of cases have a positive relationship and about 11 percent (Wood et al., 2008; Theal et al., 2009; Kamruzzaman et al., 2014; Hipp et al, 2014; Arundel&Ronald, 2017) have reported a negative relationship and the average effect size reported is 0.120. (Table No. 1).

The positive relationship between mixed land use and social capital is one of the things that has been proven in various studies (Leyden, 2003; Yoo&Lee, 2016; Oidjarv, 2018) and according to the claim of New Urbanists, it enhances the sense of community. This is while the results of the study by Kamruzzaman et al, is not consistent with the previous results and have shown the negative impact of land use diversity on both behavioral (connection with neighbors) and cognitive (trust) dimensions of social capital(Kamruzzaman et al., 2014)The findings of Dempsey's research (2009) also show that the amount of mixed-use in neighborhoods does not have a strong significant correlation with the

dimensions of social cohesion, and no relationship was found between the number of local facilities and services and participation in organized activities (Dempsey, 2009). The negative impact of cafes (Arundel&Ronald, 2017) and the negative relationship between the number of destination trips and sense of community (Lund, 2002) are other unexpected findings that have been provided in the reports.

The neighborhood alcohol outlets (Theal et al., 2009) hinder the development of social capital due to the reduction of the perceived environment safety and positive social networks. Similarly, Cohen et al (2008) in their study regarding the relationship between collective efficacy (mutual trust and willingness to help each other) and environmental feature in Los Angeles came to this conclusion that the alcohol outlets (only when tract level disadvantage was not included in the model) negatively associated with collective efficacy (Cohen et al.,2008).

On the other hand, Cohen et al. (2008) have found that presence of parks is positively associated with the improvement of collective efficacy. The researches of Lund (2003), Mason (2010), Yoo and Lee (2016), Lee et al. (2017) have also confirmed the positive impact of access to parks and green spaces on social capital. The study of Lund (2003) in Portland, Oregon, has shown that local access to parks will increase frequency of unplanned interactions and has a positive effect on local social interactions (Lund, 2003). This is while the study of Hipp et al. (2014) has shown that proximity to parks and industrial area (as social holes) has a negative effect on social capital. The presence of industrial areas in a neighborhood clearly has a negative effect and the presence of parks has a weaker negative effect on neighboring and neighborhood cohesion. The length of a river and the number of highway fragments (wedges) in a neighborhood also have a negative effect on the neighboring and social cohesion (Hipp et al, 2014).

Pedestrian access to local stores and shops (Lund, 2003; Leyden, 2003; Jun&Hur, 2015, Arundel&Ronald, 2017, Oidjarv, 2018), the average distances to destinations(Hipp et al., 2014; Tsai, 2014; Jabareen& Zilberman, 2017) and access to a sport or cultural area such as a public library in the neighborhood (Johnson, 2010; Yoo & Lee, 2016; Lee et al., 2017) are findings related to land use element in the neighborhood, that their direct relation with social capital in cognitive and behavioral dimensions is shown in various studies.

2.6.4. Street

From eleven cases examined the effects of neighborhood streets on cognitive dimension of social capital, 45 percent of the cases have a positive relationship without any negative relationship and the average effect size reported is 0.114. Among fourteen cases that researched the effects of neighborhood streets, 64% of the cases have reported positive and 7% reported negative (Hanibuchi, 2012) impacts on behavioral dimension of social capital and the average effect size reported is 0.306 which has the highest average effect size among other factors(Table No. 1).

A study conducted in England has shown that people who live in locations with higher visual integration and cluster coefficients (clustered spaces with visual links), for example living on a street corner, have more formal and informal social contacts, At the same time, places with high cluster coefficients have a negative effect on strong social contacts. This means that interconnected spaces may not create strong social bonds but may increase the number of informal social contacts (Raman, 2010).

Mason's (2010) findings regarding the design of cul-de-sac design streets are contradictory to the claim of New Urbanists to design grid layout to improve street connectivity. He found that living in cul-de-sac design streets is associated with increase of social trust, while living in a Curvilinear street negatively affects social trust, and contrary to the hypothesis, positive effect of traditional street design (grid layout) on social trust is not statistically significant(Mason,2010).This is while Lund (2002) has found that the layout of the neighborhood (a pedestrian-orientedneighborhood in grid layout) has a positive effect on sense of community and the residents of New Urbanistic (traditional) neighborhoods have a higher sense of community than the residents of car-oriented neighborhoods in the suburbs(Lund,2002).

Hopkins and Williamson (2012), who criticized the design of suburban neighborhoods for promoting political apathy, have also found a negative relationship between the residents who drive alone to work and political activities (participation in rallies and public meetings). In their study, the concept of neighborhood design is expressed by four characteristics of density, age, car-oriented development and commuting time (Hopkins & Williamson, 2012). Car-oriented development is related to neighborhood layout, and neighborhoods with more cul-de-sac design streets (less grid) are more car-oriented.

The study of Hanibuchi (2012) in the city of Nagoya, Japan, shows that the degree of urbanization as the strength of the region's connection to the center of area is clearly related to social capital. Statistical findings show that although the degree of urbanization is associated with more belonging to horizontal organizations (volunteer groups, citizen groups, sports groups, and entertainment groups), vertical organizations and mutual norms, but also to lower frequency of meeting friends (Hanibuchi. , 2012).

The results of French's study (2013) have also shown that the connectivity of the street as short distances between intersections and alternative walking routes, is significantly related to sense of community. The positive relationship between the spatial network of the neighborhood and connectivity within a radius of 600 meters and social cohesion (Cooper et al., 2014) and sidewalk continuity and neighboring (Wilkerson et al.; 2012) are other findings that confirm the direct relationship between the streets networks connectivity and continuity and social capital.

This is while the statistical analysis conducted in the study of Dempsey (2009) among six neighborhoods in England has shown that there is no relationship between the connection and permeability of neighborhood streets and any of the dimensions of social cohesion. Also his study have shown that, as the neighborhood legibility(conceptually linked to the connectedness and permeability of a place) increases, there is a possibility of reducing neighboring relations; Cremona et al, (2003) also claimed that connectedness and permeability of the built environment, contribute to attracting undesirables and vagrants and negative social interactions(Carmona et al.,2003). However, he states that legibility is not a strong predictor for negative social interactions and does not help predict social interaction (positive and negative) (Dempsey, 2009).

2.6.5. The public space

Among twenty cases that researched the effects of public space element of neighborhood, 65% have reported positive and about 5% reported negative (Kamruzzaman et al., 2014) impacts on cognitive dimension of social capital. The average effect size reported is 0.2, which is the highest average of effect size in the cognitive dimension of social capital among other factors. Also 43% have reported positive and about 17% negative (Kamruzzaman et al., 2014; Zhang et al., 2018) impacts on behavioral dimension of social capital and the average effect size reported is 0.077(Table No. 1).

Components of public spaces such as pedestrian infrastructure, graffiti, traffic calming devices, lighting and furniture (Wilkerson et al.; French et al., 2013; Jun&Hur, 2015; Holtan, 2015, Jabareen& Zilberman, 2017; Oidjarv, 2018) and maintenance of public spaces (Dempsey, 2009; Yoo&Lee, 2016, Lee et al., 2017) have a positive relationship with two dimensions of social capital. This is while the studies of Zhang et al, have shown that although greater satisfaction with the open space quality and good community administration is positively associated with higher levels of place attachment, but it will decrease the community participation. In fact, according to their findings the perceived neighborhood problems that included planning factors of the physical environment, motivates residents towards more collective actions (Zhang et al., 2018).

Zhu's study in China has shown that the increase in the number of communal spaces in the neighborhood, the frequency of group activities in the communal spaces and the appraisal of communal spaces are significantly related to community participation (Zhu, 2015). The study of Francis et al, in four local public spaces (public open space, schools, neighborhood center and shops) in Perth, Australia, has shown that the subjective distance closest public space (between 5-15 minutes), subjective quality of public open space and use public open space to relax has a significant relationship with the sense of community (Francis et al., 2012).

Access to public transportation is one of the indicators studied in the public space domain, which was introduced in the study of Jabarin and Ziberman (2017) as one of the

significant predictors of the sense of community. In this study, transportation indicator means transportation-related elements such as parking, street width, public transportation, bicycle and pedestrian routs. the positive relationship between sidewalk design and social trust (Mason, 2010), public transport accessibility and social interactions (Dempsey, 2009), walking for transportation (vs. walking for recreation) and sense of community (French et al., 2013) is another finding that confirms the positive impact of access to public transportation on social capital.

Zhang's study in Tainan, Taiwan, has also shown that easy access to the surrounding environment and transportation (separation of pedestrian and bicycle routes, access to parking) has a positive relationship with community participation and a negative association with social interactions. (Zhang et al., 2018). In the study of Kamruzzaman et al, it has been shown that public transport accessibility has a negative relationship with connection with neighbors and trust.

2.6.6. Neighborhood type

From all the examined cases, it shows that there is no significant relationship between the neighborhood type and the cognitive dimension of social capital (p<0.05). In the relationship between the neighborhood type and behavioral dimension of social capital, 44% reported positive relationship (Kim & Kaplan, 2004; Rogers & Sukolratanametee, 2009; Kamruzzaman et al., 2014), one case (Hanibuchi, 2012) reported a negative relationship and 44% reported non-significant relationship And the average effect size reported in the studies is 0.079. (Table No. 1).

In relation to the neighborhood type, it is expected that grid layout streets, mixed use and residential density of new urbanist neighborhoods, will create more social capital compared to cul-de-sac design streets, low access to destinations and low density of suburbs. Kim and Kaplan's research has also shown that the residents of Kentlands, as a new urbanist community, give a higher score to social interactions (neighboring, informal interactions, community participation and social support) as one of the indicators of a sense of community, compared to Orchard Village as a typical neighborhood (Kim & Kaplan, 2004).

Analysis of four neighborhoods in United States indicate that the designed neighborhoods have a greater sense of community in terms of supportive acts of neighboring and social ties than typical suburban neighborhoods(Rogers & Sukolratanametee, 2009). Similarly, The studies of Kamruzzaman et al (2014) have shown that when all the environmental factors such as net residential density, land use diversity, intersection density (street connectivity) and public transport accessibility; act together to form a TOD, has a positive impact on trust and reciprocity and connection with neighbors, but each independently may have an opposite impact (Kamruzzaman et al ,2014)

On the other hand, a study in Japan showed that there is no positive and significant relation between walkability

and social capital indicators. In the final model, only belongings to vertical organization such as religious, political or trade groups is significantly related to walkability score in the opposite direction to what was expected (Hanibuchi, 2012).Similarly, In Australia, Du Toit et al, (2007) did not find a statistically significant relationship between the neighborhood walkability and local social interactions, social cohesion and informal social control as indicators of sociability, and found only a weak relationship between the walkability indicator and the sense of community (Du Toit et al.,2007)

Among these contradictory and different findings, Jun and Hur (2015) have shown that when two variables of perceived walkability - the ability to walk to stores and easy walking routes - have a positive relationship with social interactions, physical walkability does not have a statistically significant relationship with social interactions. Unexpectedly, this research shows that physical walkability has a negative relationship with the sense of community as one of the cognitive dimensions of social capital, and the reason can be related to the economic and social status of the neighborhood (Jun & Hur, 2015).

3. Conclusion

With the emerge of the New Urbanism movement and the extension of sustainable development discourse from the end of the last century, attention to concepts such as social capital, sense of community, participation, etc., increased in the literature of urban design, and study on the relationship between these social concepts with the physical and the built environment was taken into account. This is while the findings of numerous researches conducted in this field during these years have been different and sometimes contradictory to each other. This made it necessary to conduct meta-analysis research about the relationship between built environment and social capital.

For this reason, this article has dealt with the quantitative synthesis of the results of researches conducted in the field of the relationship between the environmental design elements in neighborhood scale, affecting various dimensions of social capital, using the meta-analysis method.

The results show that the five neighborhood design elements, including building, density, land use, street and public space, have a significant relationship (p<0.05) with the behavioral dimension of social capital, and only the building dimension has no significant relationship with the cognitive dimension. Based on the average effect size, the street dimension has the highest impact on the behavioral dimension of social capital among other neighborhood design elements, and the public space dimension has the highest impact on the cognitive dimension of social capital. Despite the presence of negative and unexpected and non-significant findings (about 36 percent), the pedestrian-oriented and grid layout of the street networks and (Lund, 2002; Hopkins &

Williamson, 2012) and the design of an interconnected spatial network (Raman, 2010; Hanibuchi, 2012; Wilkerson et al.; 2012; Cooper et al., 2014) is the most important in promoting the behavioral dimension of social capital, including neighboring and community participation.

Improving the quality of components of public spaces and maintaining them (Dempsey, 2009; Wilkerson et al.; 2012; Francis et al., 2012; French et al., 2013; Holtan, 2015; Yoo&Lee, 2016; Jabareen& Zilberman, 2017; Lee et al., 2017; Oidjarve, 2018) and reducing the walking distance to public spaces (Francis et al, 2012; Mason, 2010) has the highest impact on improving the cognitive dimension of social capital, including the sense of community, trust and collective efficacy.

Despite the high number of data frequency related to the land use dimension directed to mixed use and access to destinations, the average effect size of the indicators connected to land use on the cognitive dimension of social capital is ranked last, but in the behavioral dimension of social capital, it is second in importance after the street dimension. The existence of mixed use (Leyden, 2003; Yoo&Lee, 2016; Oidjarv, 2018), access to parks, green space, sports and cultural areas (Lund, 2003; Johnson, 2010, Yoo&Lee, 2016; Lee et al, 2017), access to retail stores (Lund, 2003; Leyden, 2003; Jun&Hur, 2015), distance from alcohol outlets and industrial area (Theal et al., 2009; Hipp et al., 2014) promote social relations, Neighboring and social participation in the neighborhood.

The meta-analysis shows that the claims of many New Urbanist and neotraditional planners regarding the benefits of increasing density and its effect on improving trust and social relations, it will not be possible to realize in practice. Because according to the reports of the reviewed articles, the increase in density reduces the sense of community, trust, neighboring and participation. t, studies have shown that factors such as the presence of uses on the urban scale, the location of neighborhood streets, over-optimal density, etc. which increases the entrance of strangers in the neighborhood, can reduce the possibility of social relations between people and as a result, the decline of social capital.

As a result, managers, planners and urban designers should emphasize on the design of pedestrian-oriented layouts in the street network and an interconnected spatial network to promote participation and social interactions (behavioral dimension of social capital) in the decision-making and urban policy-making system. To improve social trust and the sense of community (cognitive dimension of social capital), paying attention to increasing the quality and maintenance of public spaces and access to public transportation is more important than other matters.

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Appendix 1 - summary of the studies included in the meta-analysis (in order of publication year)

	Study (year of publication)	N	Location	Independent variable	N.type	Building	Density	Land use	Street space	Public space	Ob.	Su.	dependent variable: Social capital measures	Cog.	Beh.	Method
1	Lund (2002)	106	Portland, Oregon,USA	destination walk trips / Street layout / Perception of walking				×	×	×			Sense of community	×		HLM
2	Lund(2003)	435	Portland, Oregon,USA	Park access / Retail access			×						Neighboring		×	HLM
3	Leyden (2003)	258	Galway, Ireland	Mixed use				×					Know Neighbors / Trust / Political Participation / social participation	×	×	Multivariate Logit
4	Kim & Kaplan (2004)	521	Maryland ,Washington DC,USA	New Urbanist neighborhood		×							Sense of community: social interaction / community identity	×	×	Linear regression
5	Du Toit et al.(2007)	2194	Adelaide ,Australia	Walkability		×							Sense of community	×		Multilevel regression
6	Cohen et al.(2008)	2431	Los Angeles, USA	No. parks									Collective efficacy	×		HLM
7	Wood et al.(2008)	326	Perth, Australia	no. destinations<800m distance to nearest shop				×					Social capital	×		GLM
8	Rogers & Sukolratanametee(2009)	210	Huston , Texas , USA	Neighborhood design	×								Neighboring social ties	×	×	Multiple regression
9	Theall et al. (2009)	2881	Louisiana & California , USA	Alcohol outlet density			×						Active organizational participation	×	×	HLM

Study (year of publication)	N	Location	Independent variable	Condensation of Independent variable							dependent variable: Social capital measures	Condensation of Dependent variable		Method
				Neighborhood design elements(NDEs)					NDEs measure method					
				N. type Building	Density	Land use	Street	Public space	Ob.	Su.		Cog.	Beh.	
10 Dempsey(2009)	859	UK	Residential density, Maintenance, PT accessibility, Inclusiveness attractiveness		×			×			Sense of community social interaction trust	×	×	ANOVA
11 Mason (2010)	721	Boise,USA	Street design/sidewalks			×	×				Trust	×		logistic regression
12 Johnson (2010)	132	USA	Library use			×					Trust Community involvement Civic engagement	×	×	Correlation coef.
13 Raman (2010)	207	UK	Density/privacy layout		×		×				Social interaction	×	×	Multiple regression
14 Wilkerson et al.(2012)	128	Portland, Oregon, USA	Sidewalks connectivity, Traffic calming devices/graffiti			×	×	×			Neighborliness		×	GLM
15 Hopkins & Williamson(2012)	29133	Kanawha Valley, West Virginia, San Francisco, USA	Car oriented design				×				Political participation		×	logistic regression
16 Hanibuchi et al. (2012)	9414	Nagoya, Japan	Walkability, Urbanization	×		×	×	×			Vertical org. Horizontal org. meeting friends norms of reciprocity	×	×	Logistic regression
17 Francis et al.(2012)	911	Perth, Australia	distance to the nearest ps/use pos					×			Sense of community	×		GLM
18 French et al.(2013)	1655	Perth, Australia	Attractive building, Residential density connectivity, Walk for trans./ Walking infrastructure		×	×	×	×			Sense of community	×		GLM
19 Cooper et al.(2014)	10892	Caerphilly, Wales, UK	connectivity			×	×				Social cohesion	×		multivariate regression
20 Tsai(2014)	396	Taipei, Taiwan	Housing type average travel distance	×		×	×				Sense of community	×		stepwise regression

Study (year of publication)	N	Location	Independent variable	Condensation of Independent variable — Neighborhood design elements(NDEs)						NDEs measure method		dependent variable: Social capital measures	Condensation of Dependent variable		Method
				N. type	Building	Density	Land use	Street	Public space	Ob.	Su.		Cog.	Beh.	
21	5606	Brisbane, Australia	TOD residential density land use diversity connectivity Public transport accessibility	×		×						Social Capital: trust and reciprocity Connectedness with neighbors	×	×	Multivariate regression
22	4351	Brisbane ,Australia	Distance to park Distance to industrial use				×					Neighboring Social cohesion	×	×	multilevel linear regression
23	1809	China	No.ps Appraisal of public space						×			Community participation		×	multilevel multivariate regression
24	361	Baltimore ,USA	Tree canopy						×			Social capital	×	×	Multiple regression
25	837	Franklin County, Ohio,USA	walkability density Useful shops within walking distance Easy walking paths	×		×	×		×			Senso of community social interaction	×	×	SEM
26	500	Seoul , south Korea	Land use mix Access to parks and public sport maintenance				×	×	×			Social capital	×	×	SEM
27	334	Kualalumpur , Malaysia	facilities				×		×			Trust	×		SEM
28	361	Beer Sheva , Israel	Compactness index Design & Transportation index					×	×			Sense of community	×		Stepwise multiple regression

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				Neighborhood design elements(NDEs)					NDEs measure method						
				N. type Building	Density	Land use	Street	Public space	Ob.	Su.			Cog.	Beh.	
29 Arundel& Ronald(2017)	2370	Amsterdam ,The Netherlands	Dwelling area Dwelling type frontage length density Mixed use/park/Cafes/stores Street surface area Street trees	×	×	×	×	×	(shaded)		Sense of community Social capital	×	×	multilevel regression
30 Lee et al.(2017)	49758	Seoul, South Korea	Housing type Green space/Sport space cleanliness	×		×	×	×		(shaded)	Trust Network participation			multilevel regression
31 Oidjarv(2018)	197	Chicago ,USA	Destination walking Access to local amenities			×		×		(shaded)	Perceived Neighbor support Informal problem solving Close neighborhood ties		×	multivariate regression
32 Zhang et al.(2018)	299	Tainan , Taiwan	Street layout open space quality				×	×			Community participation	×	×	Multiple regression
33 Bottini (2018)	132	Milan, Italy	Building size	×							Community participation		×	Multiple regression